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Engineering News-Record

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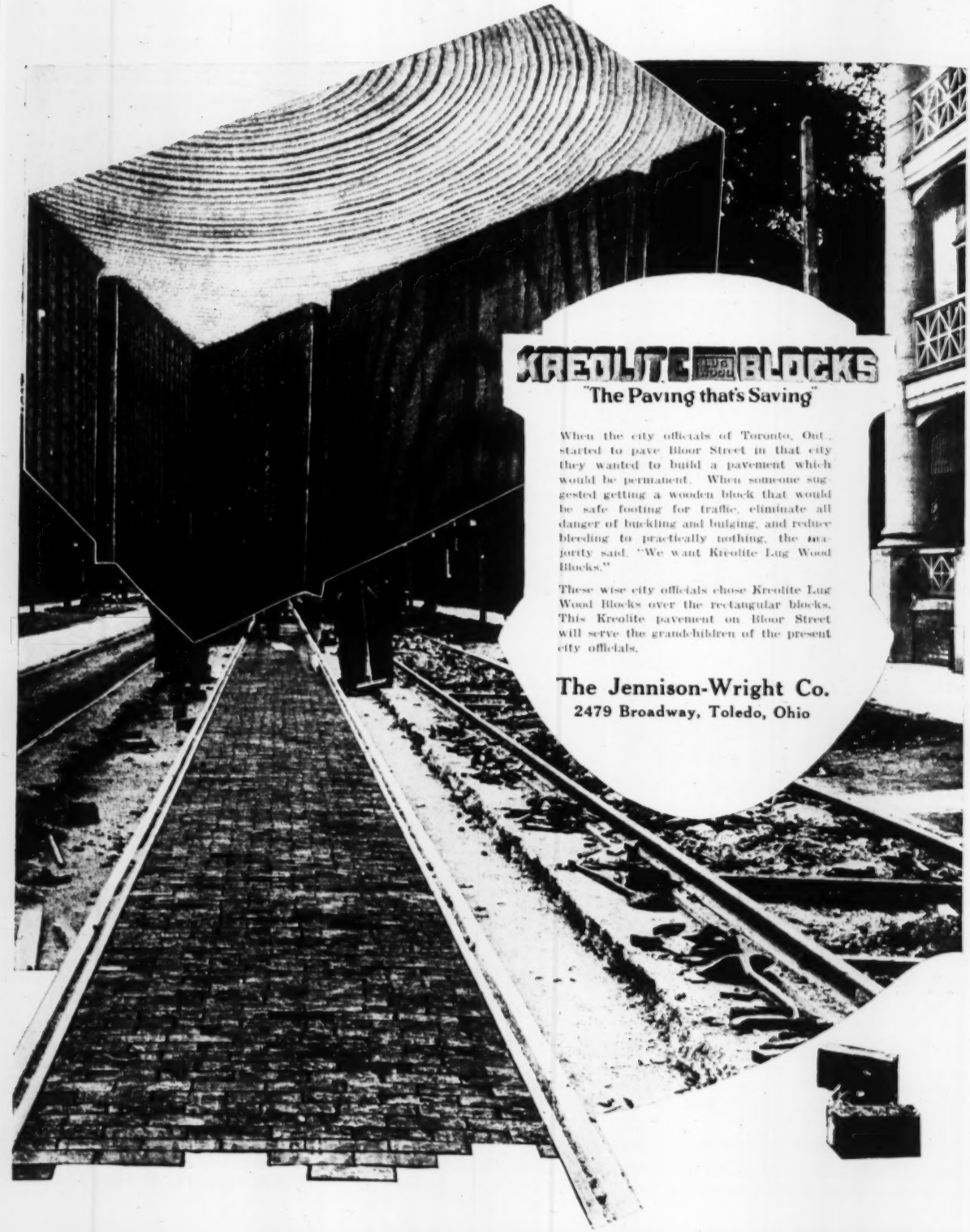
June 12, 1919

New Theories of Proportioning Concrete Examined
By G. M. WILLIAMS and WATSON DAVIS

Mechanical Handling the Feature of Concrete Pile Yard

Labor Turnover High on Two War-Time Contract Jobs
By SIDNEY G. KOON

Pneumatic Caissons Supported by Cables While Being Sunk Through Shifting Ground



KREOLITE LUG WOOD BLOCKS

"The Paving that's Saving"

When the city officials of Toronto, Ont., started to pave Bloor Street in that city they wanted to build a pavement which would be permanent. When someone suggested getting a wooden block that would be safe footing for traffic, eliminate all danger of buckling and bulging, and reduce bleeding to practically nothing, the majority said, "We want Kreolite Lug Wood Blocks."

These wise city officials chose Kreolite Lug Wood Blocks over the rectangular blocks. This Kreolite pavement on Bloor Street will serve the grandchildren of the present city officials.

The Jennison-Wright Co.
2479 Broadway, Toledo, Ohio

KREOLITE LUG WOOD BLOCKS
"The Paving that's Saving"

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. MCGRAW, President

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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor — CHARLES WHITING BAKER, Consulting Editor

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Factory Methods in Pile Casting

CIVIL engineering construction rarely lends itself to factory methods or to the utilization of the economies of multiple production of small units, but there are cases where such methods can be applied, where machinery supplants hand labor to an extent far beyond the common practice, and where there are consequent marked economies. One such instance is the pile-casting yard at the Norfolk Army base, described on another page, and another is the similar yard at the Boston Army base, which, though not here described, has many of the details of the Norfolk yard. Pile production at these yards made remarkable and regular progress, corresponding in every way to the best factory work. The application of machinery and proper routing played a large part in the results secured.

Deceiving the Draftsmen

IN THE May issue of the *Monad*, Robert W. Shelmire calls attention to the pernicious character of the advertising of certain schools for draftsmen which quote such extravagant promises as "from $35 to $100 per week to start," following a short course in mechanics or drafting. He points out that of 13 advertisements of similar tenor in *Popular Mechanics*, 10 give Chicago addresses, and calls upon the engineers of the American Association of Engineers to investigate these schools and compel them either to tell the truth or, through the force of public opinion, go out of business. We earnestly hope that action will follow Mr. Shelmire's appeal. With draftsmen generally dissatisfied, and properly so, with their compensation, matters should not be made worse by bringing new men into the ranks with promises that are not likely to be fulfilled.

Concordant Tests Wanted

CONCRETE proportioning is the livest issue today in the field of concrete. For the time the questions of cement specification and stress determination—two of the old controversies—are dormant, but the work of Edwards and Abrams reported last year has started a train of confirmatory investigation which is just now reaching publicity. Only a part of the current discussion of the subject is given in this issue; more will follow in this journal in the next few weeks, and there is little doubt that the Testing Materials and Concrete Institute conventions the last week in June will bring together in discussion several of the more important investigators. Until the time when all the current evidence shall be in, it would be futile to attempt any summary of the facts as they have been presented. It is worth while now, however, to note the dissonance of the laboratory tests as presented in the article in this issue, and to suggest to the American Society for Testing Materials and the American Concrete Institute that here is a fertile field for controlled duplication of tests in many laboratories. Until a program of experiments, laid out by some central body and conducted in many responsible laboratories, develops some concordant results, the proponents of the various theories or methods can hardly wonder that the man in the field still sticks to his old 1 : 2 : 4 mix.

Seeing Themselves as Others See Them

CONTENTED for decades with the unsurpassed scenic grandeur of its cataract, and more than content with its money-making possibilities, first from its tourist traffic and later from hydro-electric power, Niagara Falls is only now awakening to the fact that as a municipality it has done nothing to make itself attractive to either its visitors or its citizens. To a few of its people vision has come recently, resulting in some attention to city-planning needs. The City Planning Conference held at Niagara Falls May 26-29, 1919, brought home to many residents of that city for the first time how ugly the man-made part of the city is to the visitor who gets away from the river front or who views the American side of the upper part of the gorge from the Canadian side. Never before in the automobile tour of inspection that prefaces the city-planning conferences have the visitors to a conference city had so depressing a trip as the one on May 26 through the residential, business and industrial districts of Niagara Falls. This was evident to residents of the city who attended the conference sessions, and the local press advertised rather than hid the fact. It is to be hoped that seeing themselves as others see them will give impetus to the city-planning movement at Niagara Falls.

Shipbuilding at Its Climax

WITH the month of May, American Shipbuilding reached the climax of its achievement. Through the great enterprise of the Emergency Fleet Corporation, the industry was magnified ten or twenty times within the past two years. For many months its producing capacity has been in process of development, until it has now reached peak production. A total of 768,025 dead-weight tons was completed and delivered, the main part of this tonnage composed of 87 large steel vessels, averaging over 6700 dead-weight tons carrying capacity. This performance represents an increase of nearly half over the April output. Yet even the present production does not represent the full power of the remarkable shipbuilding machine which the country created, for there has been a steady contraction in operations since last November. Wood shipbuilding has been discontinued, and in the steel and concrete yards cancellation of contracts and enforcement of normal-

time schedules have slowed up the pace. At maximum output, it may fairly be concluded, a monthly production well exceeding 1,000,000 dead-weight tons might be attained with the facilities now in existence within the borders of the United States. Launchings during May lagged behind completions, apparently for the first time since our war shipbuilding began; yet with 706,000 tons launched during the month and keels laid for 596,000 tons, it may be anticipated that the May deliveries may be surpassed by a small margin for a month or two to come. In effect, however, the program is now on the decrease. Future stagnation of our great shipbuilding industry can be prevented only by foreign orders; while no relief in this direction has yet come, there are grounds for optimistic feeling. Sound conditions of demand exist, as is evidenced by some recent sales of vessels on the part of the Shipping Board in which no less than $210 per dead-weight ton was obtained. Shipbuilding for private account may therefore be expected to be fairly active after the Fleet Corporation's orders are executed. For many years, however, the production record which today is a reality will stand as an unapproachable record.

Some Shipbuilding Cost Figures

CHAIRMAN Hurley of the Shipping Board has just given out the first figures on the cost of shipbuilding under the Emergency Fleet Corporation's program. For the total of 2434 vessels, aggregating 13,885,106 dead-weight tons, $206 per dead-weight ton will have been paid when all is over. This figure includes nothing for shipyard plant extension or housing and the like, items that are separately accounted for. But while $206 is actually paid out by the Government, it is partly offset by certain important tax payments. Income and excess profit taxes have been paid by shipbuilders in amounts ranging up to $40 per dead-weight ton, and Chairman Hurley estimates that the average payment has mounted to $25 per ton. Large additional tax payments have been made by the industries that furnished materials for the ships—wood, steel, engines, and equipment—but the amounts are not readily ascertainable. It is evident, then, that the net cost of the ships to the Government has been less than $180 per dead-weight ton, by no means an extravagant figure on the general scale of the times. The actual cost to the shipbuilder, of course, is considerably lower, and this cost is the figure by which the competitive capacity of the industry will be determined.

Standardization Referred to Societies

WITH the Engineering Standards Committee's action in deciding upon complete reorganization, some difficult problems are placed before the councils of the five founder societies, whose approval or disapproval is required. As approval will mean assuming an obligation to finance the work, particular point is given to the situation, for in these times engineering societies find it necessary to inquire rather carefully whether a proposed expenditure will give commensurate return. In the case in hand the uncertainties and problems are largely chargeable to the unfortunate fact that the committee has failed to define, or even roughly describe, what the term "engineering standards" shall cover. This was a remarkable omission at the time of original organization; it is even more remarkable now. It invested the committee from the start with vagueness of purpose and function, and the impression made was not improved through the committee's failure to make contact with the profession at large. Now, with the broadening into an "association," a much enlarged body in which technical and commercial organizations of all kinds may hold membership and the founder societies will play a subordinate part, this same vagueness is intensified, to the extent of inspiring doubt as to the engineering control and even as to the technical status of the association's future activities.

The officials of the committee have decided to withhold the details of the proposed reorganization from public knowledge until the founder societies have had an opportunity to act. It may be assumed, however, that the general scheme sketched by Dr. E. B. Rosa in *Engineering News-Record* of May 1 and May 8, 1919, is to be followed, though perhaps on a reduced scale. The motive leading to reorganization was to extend the scope of the committee's work to cover the preparation of industrial safety codes, such as rules for the construction of elevators, ladders or machine guards—something rather widely different from specifications for materials, standards for machine screws, or sizes of hydrant threads.

In these circumstances three important questions present themselves: What field of work will the association occupy? Is this field now taken care of in reasonably satisfactory manner? Will the association improve the results now being achieved, or will it injure or destroy existing institutions? These questions, concerning which the committee itself has hitherto maintained silence, are at the core of the difficulties referred to. As we suggested in our issues of Apr. 10 and Apr. 17, the issue is the sound continuance of most important work now being carried on, and perhaps even the survival of societies now flourishing.

Will Large Contracting Organizations Take Up Highway Work?

OF LATE there has been much urging of large contracting organizations to engage in highway work. The large future confronting the highway field has been pointed out, as well as the opportunity to secure sizable contracts worthy of the resources and skill of large organizations.

From the standpoint of the public there can be no doubt that it is desirable to let contracts for long stretches, provided capable contracting organizations having sufficient resources to buy adequate plants can be induced to take up the work.

But how does the large contracting organization regard the highway field?

To answer that question one of the editors of *Engineering News-Record* has sought the opinion of the officers of some large construction companies which have heretofore engaged in other work than highways but which are now contemplating entering the highway construction field. Their views, as summarized by Mr. Hill, will be found on p. 1150 of this issue. The story merits the most careful consideration of highway engineers.

In many of the charges which Mr. Hill sets down, as the temporary spokesman for these large contracting companies, will be recognized faults frequently alleged

against those who employ contractors, whether public officials or small private owners. Great as has grown the volume of construction work in recent years (until the war came) there has been no conspicuous change in the relationship between contractor and owner on the general run of small and average-size public-works jobs. There the contractor is still mistrusted and is not accorded the standing given to any other business man. Obviously, there are some things that cannot be fully defined in the specifications, and for the interpretation of these clauses the contractor is in the hands of the engineer. That is to be expected, but the insertion of meticulous clauses which at the sole judgment of the engineer, or of a subordinate under him, may be used to the disadvantage of a contractor is not conducive to that kind of relationship which should exist in a contract supposed to be mutual. These clauses can be offset only by a reputation for fair treatment, and such a reputation, the contractors believe, has not been established.

That the just causes for complaint must be removed needs no long demonstration. For a time the large contracting organization will be glad to take any work to keep busy, but just as soon as there is opportunity to pick and choose—in other words, when the volume of construction approaches that of the pre-war period—the large, competent, financially strong construction organization will select work in which the relationship not merely leads to profit but rests on the conviction of the owner that the contractor for a fair price will do a thoroughly good piece of work.

If the big contracting organization by the time the pre-war demand is approximated has not found the assurance that it will find in the highway field fair compensation and fair treatment in return for honest work, it will employ its resources elsewhere and the great opportunity which now lies before engineers to secure the services of these competent organizations for the benefit of the public will have disappeared.

We recognize, and so does Mr. Hill, that legal requirements are responsible for some of the undesirable features in public-works contracts. But, as Mr. Hill well says, the facts alone are important.

The Growth of the Draftsmen's Unions

FROM various parts of the country come reports of the rapid growth of draftsmen's unions. The international federation states that it has 5000 members in 25 locals, and that the Chicago branch alone has 700 members. In certain of the municipal departments in New York a majority of the draftsmen have joined, while in San Francisco not only have most of the draftsmen entered the union but 85 per cent. of the assistant engineers in municipal service as well.

While at first thought such growth is surprising, it is evident on reflection that it is but another manifestation of the dissatisfaction with compensation that has been with us for the past eight or ten years. That dissatisfaction has, of course, increased very materially on account of the price changes during the war.

To understand what is happening, however, one needs but to recall that six years ago a committee was appointed by the American Society of Civil Engineers to study the subject. That was evidence of dissatisfaction, and a groping after a remedy. Later came the American Association of Engineers with a welfare program that included the matter of compensation, and its rapid growth has certainly been due in part to its emphasis on this question. Now another agency comes forward, and, pointing to its effectiveness in other lines, offers its aid in the effort to get higher compensation.

Nor are the unions and the American Association of Engineers alone in making efforts in this direction. Engineering Council appeared before the railroad wage board and at the present time has at work a committee on compensation and classification of engineers. Its three subcommittees—on Federal, railway and on state and municipal employment—are actively at work making their classifications and getting the necessary data on which to build the proposed minimum salary grades.

The procedures, whether of Engineering Council or of the unions, rest on the theory that engineers must resort to collective bargaining in order to get higher pay. That theory was not accepted, or at least not advanced, by the civil engineers' reports in 1914 and 1917.

Therefore, the organizations at the extremes—the national technical societies (functioning through Engineering Council) on the one hand and the unions on the other—are at one in their theory. The divergence is one of method. The more conservative members of the profession are fearful of the use of "union methods," including the strike, or threat of strike. Those who seek quick results, however, wonder whether effective action can be counted on from the national societies, or their representative, Engineering Council. Right here the two wings join issue.

We have no doubt that the lowliest draftsman, ineligible to membership in the national technical bodies, would much prefer to see the results come through the action of the societies than through the union. He is interested in results chiefly, of course, but is not blind to the prestige which would accrue to all engaged in engineering work if the profession took care of its own. The strike, moreover, does not appeal to men of the type engaged in engineering work, and we should expect considerable defection if a strike were called.

What weapons, then, remain for getting results? There are at least two—the force of public opinion and the mediation of Government agencies. Upon these, both Engineering Council and the American Association of Engineers are relying. They can be made effective agencies, without doubt, but their effectiveness requires well-directed publicity, with a full and strong showing of fact.

What the outcome of present efforts will be remains to be seen. Shall we recede, now that we have advanced so far as accepting the theory of collective action on compensation? In England, as the Webb report on professional organization showed (*Engineering News-Record*, Apr. 10, 1919 p. 712), collective action on compensation is a confirmed part of the procedure of professional societies. Despite what has happened in England, however, it is hard to predict that we shall adopt the method permanently. The draftsmen will retain it, but will the professional engineering bodies? Likewise, it is impossible to tell what will happen as the result of another year or two of effort to secure higher remuneration. The effectiveness of the various procedures will be closely watched, and also the manner of the doing.

Meanwhile, it is important that all should know what efforts are under way, and particularly that those who desire action but are not in sympathy with the idea of getting it through the unions should realize that other bodies have the matter actively in hand.

Tests of Two Recent Theories for Proportioning Concrete

Fineness-Modulus and Surface-Aggregate Methods, Both of Which Depend on Water-Cement Ratio, Do Not Seem to Insure the Necessary Workability of Mix

By G. M. Williams and Watson Davis

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The following tests, made at the United States Bureau of Standards, controvert the fundamental principles of two theories for proportioning concrete which are receiving current attention. Following the article will be found a reply by Prof. D. A. Abrams, the propounder of one of the theories. A reply from Captain Edwards, the advocate of the other theory, will appear in an early issue—Editor.

During the past year two new theories for the proportioning of concrete mixtures have been proposed. One, fully described by Prof. D. A. Abrams in Lewis Institute Bulletin No. 1, "Design of Concrete Mixtures" (see *Engineering News-Record* of Apr. 17, 1919, p. 758), is based upon tests which seem to show that the strength of concrete depends only upon one factor, the ratio of mixing water to cement. The second, proposed by L. N. Edwards of Toronto and presented at the 1918 convention of the American Society for Testing Materials (see *Engineering News-Record* of Aug. 15, 1918, p. 317), bases the quantity of cement upon the surface area of the aggregate and includes a formula for quantity of mixing water to produce concretes having equal plasticity and equal strength. Studies now under way in the Bureau of Standards indicate that neither of these two methods insures what is most necessary in practical concrete work—that is, a proper "flowability" or workability. Some of the results of these tests are given here in proof of this assertion.

The above Bulletin No. 1 states that for a given plastic condition of the concrete and the same mix there is an intimate relation between the fineness modulus of the aggregate and the strength and other properties of the concrete. The grading of the aggregate may vary over a wide range without producing any effect on concrete strength, so long as the cement-water ratio remains unchanged. Referring to the sieve-analysis curves, it is said that any other analysis curve which will give the same total area below the curve corresponds to the same fineness modulus, and will require the same quantity of water to produce a mix of the same plasticity, and gives concrete of the same strength, so long as it is not too coarse for the quantity of cement used. In other words, for given concrete materials the strength depends upon one factor only—the ratio of water to cement.

The "surface-area" method of proportioning assumes as its basic principle that the physical properties are primarily dependent upon the relation of the volume of cementing material to the surface areas of the aggregate.

It is stated that the strengths of mortars are dependent upon the quantity of cement in relation to the surface areas of the aggregates, and the consistency of the mix. Also, that strengths of mortars of uniform consistency containing sand aggregates of varying granular combinations are directly proportional to the quantity of cement they contain in relation to the surface area of the aggregate. It was found that "normal," uniform-consistency mortars of varying cement content and of varying sand gradings were produced when the quantity of water used in the mix was made equal to that required to reduce the cement to a normal-consistency paste, plus an amount equal to the surface area of the sand in square inches divided by 210, i.e.,

$$(l)\ \text{Water (cc.)} = \left(\begin{array}{c}\text{Weight of cement } (C) \times \\ \text{Percentage required to produce} \\ \text{"normal"-consistency paste}\end{array}\right) \frac{\text{Total surface area of sand (sq. in.)}}{210}$$

As shown above, the water-cement ratio method, in final result, is not concerned with details of proportioning the cement or grading of the aggregate, but, regardless of the reason for varying the water content, the water ratio dictates once for all the concrete strength.

TABLE I. PHYSICAL CHARACTERISTICS OF AGGREGATES POTOMAC RIVER SAND AND GRAVEL

Aggregate Number	Weight per Cu. Ft., Lb.	Surface Area, Sq.In. per 100 Gram	Fineness Modulus	Granular Analysis, Per Cent. retained on 1½	¾	½	4	8	14	28	48	100	Pass 100
40	120	126	6.04	0	24	49	68	81	90	95	98	99	1
264	131	285	6.04	0	62	67	67	67	75	82	89	95	5
270	130	261	6.04	0	38	60	80	80	80	80	90	96	4
271	122	156	6.04	0	23	50	75	81	87	92	96	100	0
274	136	305	6.04	0	56	66	73	75	78	81	85	90	10
276	116	91	6.04	0	26	45	60	81	92	100	100	100	0
278	119	113	6.04	0	28	50	55	84	92	96	99	100	0
280	129	287	6.04	0	57	57	57	83	84	84	84	98	2
1	119	268	5.40	..	0	50	60	86	86	86	86	86	14
2	100	102	5.40	..	00	2	48	96	97	98	99	100	0
3	115	201	5.40	..	0	16	74	86	88	90	92	94	6
4	126	348	5.40	..	0	48	80	80	80	80	80	92	8
5	125	294	5.40	..	0	62	66	70	78	82	88	94	6
6	116	178	5.40	..	0	50	56	66	78	92	99	99	1
7	115	160	5.40	..	0	34	60	72	83	91	100	100	0
8	111	115	5.40	..	0	20	56	76	88	100	100	100	0
9	120	269	5.26	..	0	41	63	71	77	82	92	98	0
51	103	174	4.55	..	..	0	12	56	90	98	99	100	0
53	120	576	4.55	..	..	0	68	68	68	80	85	86	14
55	106	211	4.55	..	..	0	20	60	83	96	96	100	0
57	118	568	4.55	..	..	0	70	71	72	74	74	94	6
58	102	165	4.55	..	..	0	6	56	96	98	99	100	0
61	97	50	6.00	..	..	0	100	0	..	..	..	..	..
62	112	270	4.60	..	..	0	60	60	60	80	100	..	..
63	98	300	3.20	..	..	..	..	0	40	80	100	..	..
64	108	310	4.00	..	..	0	20	40	60	80	100	..	..
65	90	800	2.00	..	..	..	..	..	..	0	100	..	..
66	93	420	4.00	..	..	..	..	0	10	90	100	..	..

* Surface areas for aggregates 1...9, 40, 264...280 are computed under the assumption that the surface areas of particles passing the 100 mesh sieve are the same as the areas of those retained for unit weight, as was done by Mr. Edwards.

The "surface-area" method requires the selection first of some ratio of cement to surface area of aggregate, such as 1 g. cement to 10, 15, 20, or 25, etc., sq.in. of area. With this ratio fixed and with the quantity of mixing water determined by the above formula, mortars of the same plasticity and of the same strength are said to result.

It is important to note here that *the "surface-area" method after fixing a ratio of cement to surface area of aggregate arrives at the same final conclusion as does the method proposed by Professor Abrams—that strength depends only upon the ratio of mixing water to cement.*

The proof of this statement is as follows: Let

C = Weight of cement in grams.

p = Percentage of water for normal consistency of the cement.

A = Total surface area of aggregate in square inches.

$N = A/C$ = square inches of surface area of aggregate per gram of cement. Arbitrarily selected before test.

w = c.c. mixing water.

c = volume of cement in cubic centimeters.

As given previously

$$w = pC + \frac{A}{210} \quad (1)$$

From above $$A = NC \quad (2)$$

Substituting (2) in (1)

$$\frac{w}{C} = p + \frac{N}{210} \quad (3)$$

in which p and N are constants. To express the weight of cement in the form of volume

$$\frac{w}{0.67c} = p + \frac{N}{210} =$$

constant, which is the water-cement ratio proposed by Professor Abrams for equal strength, or

$$\frac{w}{c} = K$$

It appears from the foregoing that with w/c constant, Professor Abrams should obtain constant strength values in every case, while Mr. Edwards by his theory should obtain constant strength values if the cement content is proportional to the surface area of the aggregate, or if the mixtures be made up by the usual volume method of proportioning, the strengths should vary inversely as the surface area per unit volume of aggregate. In support of the first theory it is shown in Table II of Lewis Institute Bulletin No. 1 that the strengths of 27 concretes made with the same ratio of water to cement are essentially the same, whereas the surface areas of the aggregates per gram of cement varied from 5.6 to 31.3. If the first theory is correct, it would seem that the surface area of the aggregate has little apparent influence on strength, while if the second is correct, varying strengths should have been obtained for the concretes included in the above table.

Relation of Flowability of Concrete to Tests

The fundamental requirement in the process of concreting is plasticity, flowability, workability or whatever that property may be called which makes a concrete placeable with a reasonable amount of work. It is essential that this factor receive proper consideration in the laboratory. For the same flowability an aggregate containing much fine material will require a greater amount of water than one which carries little fine. The judgment of the operator cannot be depended upon to insure concretes of equal flowability when the proportions of cement to aggregate or gradation of the aggregate in the same proportions varies widely, as must often be the case. The adoption of the "slump test" or the "cylinder pull off," as applied to the freshly mixed concrete, was a great step forward in the control of this important factor, but we have found that the cylinder slump test is of value only over rather small ranges of consistencies. It often gives misleading results when used near the limits of these ranges when comparing lean and rich proportions, and also for proportions leaner than 1 : 1 : 2, depending somewhat upon the gradation of the aggregate.

In most of the tests, descriptions of which follow, consistency determinations have been made, both with the cylinder and with what seems to be a more logical and satisfactory means of determining the flowability; that is, with the vibrating steel plate. The plate is supported at its center and on the center of the plate a fixed quantity of concrete is molded in a cylindrical

TABLE II. TESTS OF MORTARS WITH CONSTANT WATER-CEMENT RATIO

(See Fig. 1)

Showing reduction in compressive strength and flowability by the addition of increasing proportions of fine and coarse aggregate to a constant weight of cement and mixing water (w/c constant)

Results are average of three 2 x 6-in cylinders stored in damp closet

Proportions by Weight, Cement	Aggregate	Mixing Water, per Cent. by Weight	*w/c	Density	Surface Area, Sq.In. per Gram Cement	Standard Ottawa Sand: Flowability 3 x 6-In. Cyl. Slump In.	Standard Ottawa Sand: Flowability Vib. Plate	Standard Ottawa Sand: Compressive Strength, Lb. per Sq.In. 7 Days	Standard Ottawa Sand: Compressive Strength, Lb. per Sq.In. 28 Days	¼-½ in. Gravel: Density	¼-½ in. Gravel: Surface Area, Sq.In. per Gram Cement	¼-½ in. Gravel: Flowability 3 x 6-in. Cyl. Slump In.	¼-½ in. Gravel: Flowability Vib. Plate	¼-½ in. Gravel: Compressive Strength, Lb. per Sq.In. 7 Days	¼-½ in. Gravel: Compressive Strength, Lb. per Sq.In. 28 Days
1	0	31.0	0.465	0.498	0	2½	242	5570	6660	0.498	0	2½	237	5680	7280
1	½	20.7	0.465	0.613	2.0	2½	230	5580	6710	0.603	0.125	1½	225	4380	5170
1	1	17.7	0.465	0.640	3.0	1½	226	5090	6210	0.652	0.188	1½	200	4240	4710
1	1½	15.5	0.465	0.669	4.0	1½	222	5130	5870	0.673	0.250	1½	187	3940	4970
1	1½	12.4	0.465	0.706	6.0	—	180	4370	5200	0.726	0.375	—	160	3300	3950
1	2	10.3	0.465	0.720	8.0	0	135	3365	4060	0.753	0.500	0	137	3060	3300

*$\frac{w}{c}$ = $\frac{\text{volume mixing water}}{\text{volume cement}}$

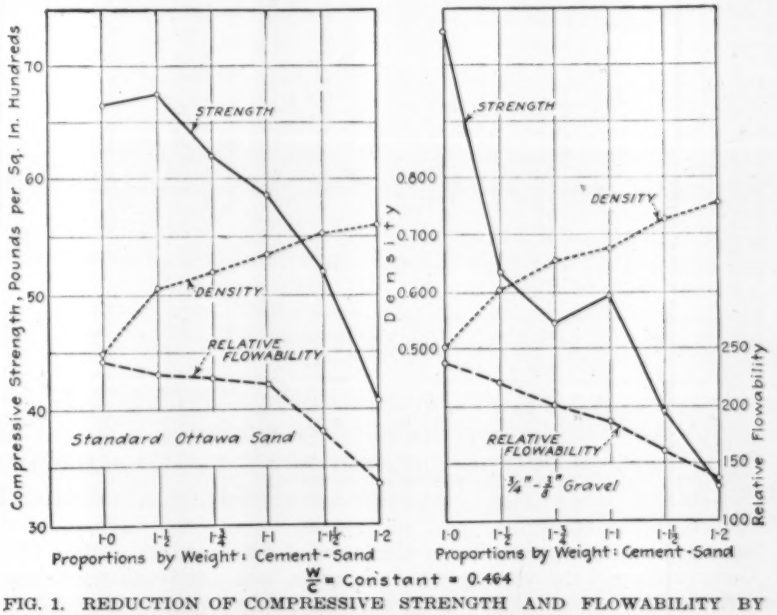


FIG. 1. REDUCTION OF COMPRESSIVE STRENGTH AND FLOWABILITY BY ADDITION OF INCREASING PROPORTIONS OF FINE AND COARSE AGGREGATES TO A CONSTANT WEIGHT OF CEMENT AND MIXING WATER (SEE TABLE II)

form whose height is one-half its diameter, the form is removed and the edge of the plate is struck a fixed number of measured downward blows. The increase in diameter of the concrete expressed in per cent. is designated as relative flowability.

The conditions of the tests were as follows:

Cement—A standard brand of portland cement has been used throughout the series of tests shown.

Storage—All specimens were stored in damp closet or in water, as indicated. A relative humidity of between 90 and 95% was constantly maintained in the damp closet.

Testing—All compression tests were made on standard testing machines of 20,000- and 100,000-lb. capacities. The 6 x 12-in. cylinders were capped one end before testing and the other end was ground to a plane surface. The 3 x 6-in. cylinders were capped top and bottom with neat cement paste at the time of molding and the ends were ground plane just previous to the test.

TABLE III. MORTARS MADE OF WIDELY VARYING GRANULAR COMBINATIONS
(See Fig. 2)
(Results Average of two 2-in. cubes at 7 days and three 2-in. cubes at 28 days stored in water)

Proportions—1 part cement to 3 parts aggregate by volume

Aggregate Number	Fineness Modulus	Surface Area, Sq. In. per Gram Cement	Constant Water Ratio: Mixing Water Per Cent by Weight	Constant Water Ratio: *w/c	Constant Water Ratio: Density	Constant Water Ratio: Compressive Strength Lb per Sq. In. 7 Days	Constant Water Ratio: Compressive Strength Lb per Sq. In. 28 Days	Constant Flowability: Mixing Water Per Cent. by Weight	Constant Flowability: *w/c	Constant Flowability: Density	Constant Flowability: Compressive Strength Lb. per Sq. In. 7 Days	Constant Flowability: Compressive Strength Lb. per Sq. In. 28 Days
61	6.00	1.6	10.10	0.622	0.757	2890	5190	11.67	0.667	0.730	2290	4050
62	4.60	9.7	9.00	0.622	0.782	3735	5405	11.34	0.780	0.744	2465	4630
63	3.20	12.5	10.05	0.622	0.711	2020	3140	13.15	0.819	0.675	1590	3155
64	4.00	10.7	9.27	0.622	0.757	3060	4590	†12.95	0.865	0.703	1810	3635
65	2.00	22.8	10.73	0.622	0.628	1120	1705	19.10	1.104	0.598	705	1465
66	4.00	12.4	10.52	0.622	0.625	2040	3130	14.60	0.867	0.620	1340	2460

$*\frac{w}{c} = \frac{\text{volume of mixing water}}{\text{volume of cement}}$

† Too much water used.

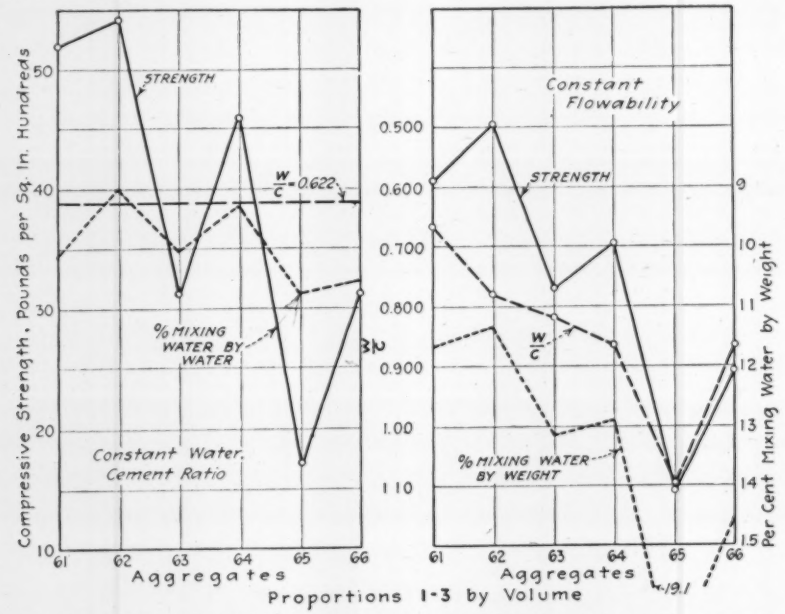


FIG. 2. STRENGTH TESTS OF MORTARS OF WIDELY VARYING GRANULAR COMBINATIONS (SEE TABLE III)

Tests of the Proposed Methods

In Table I are shown the granular analyses and other physical properties of the aggregates included in the tables following.

In Table II (graphically in Fig. 1) are shown the results of tests made by combining constant weights of cement and mixing water with varying percentages of standard Ottawa sand, and of gravel passing the ¾-in. and retained on the ¾-in. screen. These mixtures are much richer than most mortars ordinarily used in practice, but were made to show the effect of addition of very different aggregates with a constant water-cement ratio. The quantities of aggregate are varied from 0 to 2 parts by weight of the cement. With increase of added aggregate it is seen that density (that is, the ratio of volume of solids, cement and aggregate, to a unit volume of concrete) increases while strength decreases. It is also seen that the mixtures containing standard sand are stronger than those containing the coarser gravel. In general, it was found that flowability was reduced more by the addition of the coarse aggregate than the fine. This was indicated equally well by the slump test and the vibrating plate, and was noticeable to the eye at the time the specimens were molded. Had sufficient mixing water been used in every case to give the same flowability as was obtained for the neat cement, still greater reductions in strength would have resulted.

Attention is also directed to the relation between surface area and strength. In every case the surface areas of the standard sand mixtures are 16 times as large as for the gravel mixtures of the same proportions, and the strengths are considerably higher.

It is usual to conceive of concrete as being made

Aggregates—The aggregate, sand and gravel, from the Potomac River, used generally in all classes of concrete construction in the vicinity of Washington, was screened into its various sizes, using screens of the Tyler standard screen scale.

Proportions—All proportions, unless indicated otherwise, are by volume, reduced to weight measure for accuracy.

Method of Mixing—All concrete for 3 x 6-in. cylinders was mixed by hand in large, sheet-metal pans. All specimens in any one series were molded the same day by the same operator. Concrete for 6 x 12-in. specimens was mixed in a batch mixer.

TABLE IV. CONCRETES MADE WITH AGGREGATES HAVING THE SAME FINENESS MODULUS
(See Fig. 3)

(Showing the variation in compressive strength and flowability with constant water-cement ratio (w/c constant), also same aggregates with flowability constant)

Results, average of four 3 x 6-in. cylinders stored in damp closet.
Proportions, 1 part cement to 3 parts aggregate by volume.

			Constant Water Ratio					† Constant Flowability				
Aggregate	Fineness Modulus	Surface Area, Sq.In. per Gram Cement	Mixing Water, Per Cent. by Weight	*w/c	Density	Flowability, 3 x 6-In. Slump, In.	Compressive Strength, Lb. per Sq.In., 28 Days	Mixing Water, Per Cent. by Weight	*w/c	Density	Flowability, 3 x 6 In. Slump, In.	Compressive Strength, Lb. per Sq.In. 28 Days
1	5.40	15.2	11.50	0.830	0.747	1¼	2350	11.32	0.830	0.758	1¼	2590
2	5.40	3.2	13.16	0.830	0.719	3	1830	11.09	0.699	0.740	¼	2380
3	5.40	7.4	11.82	0.830	0.749	2½	1810	10.72	0.752	0.758	½	3030
4	5.40	14.0	11.00	0.830	0.766	3½	2490	11.23	0.848	0.755	1¼	2700
5	5.40	11.7	11.06	0.830	0.764	3	2230	10.32	0.776	0.771	¼	3160
6	5.40	6.6	11.73	0.830	0.762	3¾	2305	10.60	0.748	0.764	¼	3460
7	5.40	5.9	11.81	0.830	0.751	3¾	1930	10.13	0.713	0.758	¼	3410
8	5.40	4.0	12.13	0.830	0.739	3	1870	10.52	0.719	0.754	¼	3210
9	5.26	11.6	11.42	0.830	0.758	2¼	2645	10.52	0.765	0.770	¼	3220

$*\frac{w}{c} = \frac{\text{volume mixing water}}{\text{volume cement}}$

† Judged by eye and flow when heaped and shaken, checked by cylinder slump test; probably not so exact as later flowability determinations.

up of an aggregate glued together with cement paste. In view of the results shown in Table II it would seem to be more accurate to consider a concrete as being made up of a relatively small quantity of neat cement paste separated and diffused throughout the mass of a large volume of inert adulterant, which results in economy at the expense of strength.

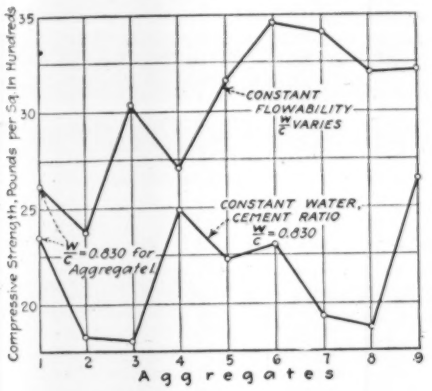

Compressive Strength, Pounds per Sq. In Hundreds
CONSTANT FLOWABILITY W/C VARIES
CONSTANT WATER, CEMENT RATIO W/C = 0.830
W/C = 0.830 for Aggregate 1
Aggregates

FIG. 3. CONCRETES WITH AGGREGATES OF SAME FINENESS MODULUS

Showing the variation in compressive strength with constant water-cement ratio and also the same aggregates with flowability constant. (See Table IV.)

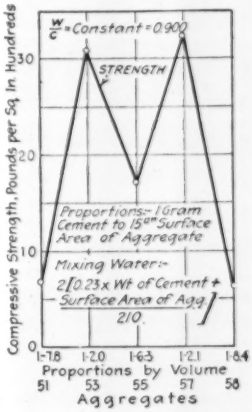

W/C = Constant = 0.900
STRENGTH
Proportions:- 1 Gram Cement to 15 sq in Surface Area of Aggregate
Mixing Water:- 2[0.23 x Wt of Cement + Surface Area of Agg / 210]
Compressive Strength, Pounds per Sq. In Hundreds
1-7.8 1-2.0 1-6.3 1-2.1 1-8.4
Proportions by Volume
51 53 55 57 58
Aggregates

FIG. 4. STRENGTH OF MORTARS PROPORTIONED BY THE SURFACE AGGREGATE METHOD
(See Table V)

In Table III (graphically in Fig. 2) are shown results of tests made by combining one part cement to three parts of aggregates of widely varying granular composition. In one case the water-cement ratio was kept constant, and in the second group the water content was varied to give mixtures having constant flowability. The main points to be noted in this series of tests may be stated as follows: There appears to be little relation between surface area of the aggregate and compressive strength, and with constant water-cement ratio, compressive strength is not constant but varies greatly for the different aggregates when combined in the proportion of one part cement to three parts aggregate.

In the tests shown in Table IV (graphically in Fig. 3) all aggregates have the same fineness modulus, 5.40, with the exception of No. 9, which has 5.26 for its modulus. One part of cement was combined in every case with three parts of aggregate by volume. In one set the water-cement ratio was maintained constant ($w/c = 0.830$) and in the second the quantity of mixing water was varied to give constant flowability. With w/c constant, the flowabilities were found to vary more than is indicated by the results given by the slump test. This was apparent under the trowel and to the eye at the time the test pieces were molded, and was later confirmed when the series was duplicated with flowability constant.

It is seen that with w/c constant there was not only considerable variation in flowability but also a marked difference in compressive strength. Aggregates Nos. 3, 5, 6, 7 and 8 showed large increases in compressive strength when w/c was varied to give equal flowability as compared with No. 1, which was used as the base.

Increase in mixing water generally results in lower strength, but the magnitude of the change in strength varies for each aggregate.

Briefly, there is no apparent relation between surface area of aggregate and strength; also flowabilities and strength were not found constant for a constant w/c.

The series of tests shown in Table V (Fig. 4) was planned to meet requirements of the surface-area method of proportioning. As noted in the table, the actual proportions varied from 1 : 2.0 to 1 : 8.4 by volume, due to the use of 1 g. of cement for every 15 sq.in. of surface area. As for the aggregates shown in the preceding tables, the surface-area calculation is based on the assumption that the particles are spheres and

TABLE V. TESTS OF MORTARS PROPORTIONED BY THE "SURFACE AREA" METHOD
(See Fig. 4)

Proportions—1 gram cement to 15 sq.in. surface area of aggregate;

$$\text{Mixing water} = 2\left(.23 \times \text{Weight of Cement} + \frac{\text{Total surface area of aggregate}}{210}\right)$$

Results average of two 2-in. cubes at 6 days, three 2 in. cubes at 28 days stored in water

Aggregate Number	Grams Aggregate	Total Surface Area, Sq.In.	—Mixing Water— Weight	c.c.	Per Cent. by Weight	$*\frac{w}{c}$	Proportion by Volume	Density	Compressive Strength Lb. per Sq.In. 6 Days	28 Days
51	1200	2090	140	84	6.28	0.900	1:7.84	0.686	535	680
53	1200	6920	470	282	16.90	0.900	1:2.00	0.692	1685	3085
55	1200	2540	169	102	7.45	0.900	1:6.30	0.740	1010	1720
57	1200	6700	448	270	16.40	0.900	1:2.13	0.696	1755	3230
58	1200	1980	132	80	6.01	0.900	1:8.36	0.675	510	635

$*\frac{w}{c} = \frac{\text{volume mixing water}}{\text{volume cement}}$

TABLE VI. CONCRETES MADE WITH POTOMAC RIVER AGGREGATES HAVING THE SAME FINENESS MODULUS

(See Fig. 5)

Figures in parentheses show corresponding values for Elgin aggregate as given in Table 2, Bulletin 1, Lewis Institute

Showing the variation in compressive strength and flowability with constant water-cement ratio (w/c constant)

Results, average of five 6 x 12-in. cylinders stored in damp closet
Proportions, 1 part cement to 5 parts aggregate by volume

Aggregate	Fineness Modulus	Mixing Water: Per Cent. by Weight	Mixing Water: *w/c	Flowability: 6 x 12-In. Cyl. Slump, In.	Flowability: Vibrating Plate	Density	Surface Area, Sq. In., Gram Cement	Compressive Strength, Lb. per Sq.In. 28 Days
40	6.04	8.10	0.898	7¼	172	0.793	8.0 (8.8)	2315 (2890)
264	6.04	7.51	0.898	†0	116	0.822	19.8 (25.2)	2470 (2580)
270	6.04	7.54	0.898	½	135	0.818	18.0 (21.5)	2230 (2550)
271	6.04	7.98	0.898	8½	180	0.812	10.1 (10.0)	1820 (2710)
274	6.04	7.26	0.898	0	131	0.836	22.0 (31.3)	1760 (2440)
276	6.04	8.32	0.898	0	155	0.798	5.6 (5.6)	1880 (2780)
278	6.04	8.08	0.898	¼	170	0.801	7.1 (7.0)	1910 (2750)
280	6.04	7.61	0.898	†0	135	0.818	19.7 (19.7)	2610 (2780)

*w/c = volume mixing water / volume cement

† Cylinder picked up in hands without losing shape and carried back to mixer.

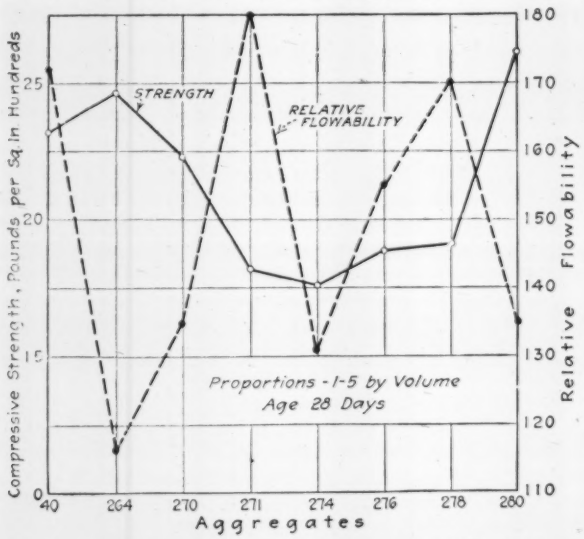


FIG. 5. CONCRETES MADE WITH AGGREGATES HAVING THE SAME FINENESS MODULUS

Showing variation in compressive strength and flowability with constant water-cement ratio (See Table VI)

that their average diameter is the mean of the openings in the sieve passed through, and retained on. Values obtained are only approximate, but are probably proportional to the true areas, which it is impossible to determine.

The formula proposed for determining the quantity of mixing water furnishes far too small an amount of water to produce a workable mix for all aggregates. In these tests the quantity was doubled, and those aggregates having small surface areas were too dry, and those with large surface areas entirely too wet.

Water Formula Is Inadequate

The inadequacy of the water formula is shown by comparing the amount which it would specify for a 1:3 standard sand mortar with the quantity which is ordinarily used in the laboratory.

Percentage for normal consistency = 24.

Surface area standard Ottawa sand = 400 sq.in. per 100 grams.

Assume batch of 500 grams cement and 1500 grams sand.

By "surface-area" water formula

$$\text{Water} = 0.24 \times 500 + \frac{6000}{210} = 148.6 \text{ cc. or } 7.42$$

per cent.

The United States Government specification for portland cement specifies 10.5% of mixing water for a cement having a normal consistency of 24. Water = 10.5 × 2000 = 210 cubic centimeters.

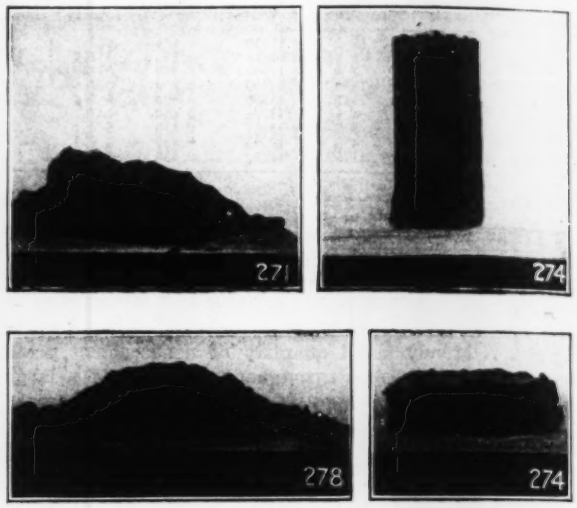


FIG. 6. RESULTS OF SLUMP AND FLOWABILITY TESTS OF THREE AGGREGATES. NOTED IN TABLE VI

Upper views show conditions after completing the cylinder slump tests; lower two views show specimens after the flowability tests

The "surface-area" normal-consistency mortar would therefore contain 61.4 less grams of water for a batch of 2000 grams.

It was foreseen that strict adherence to this formula was impracticable, and all calculated water quantities were therefore multiplied by 2, resulting in a constant water-cement ratio of 0.900. A very large proportion of the advantage which should have been obtained in the rich mixtures was thrown away by the excessive quantity of mixing water. It is an admitted fact that the granular composition of an aggregate is reflected by the amount of water required to produce a concrete of the same flowability, but, as shown previously, since the water-cement ratio is constant, no consideration is given to variation in the amount of surface area. The formula is equivalent to one which bases the water required on cement content only.

In view of these tests and the variation in water required for different proportions, or for aggregates varying widely in granular composition in the same proportion, it is difficult to see how by any chance a 1:2 could be compared with a 1:8 combination as to strength, as stated in Lewis Institute Bulletin No. 1, if proper consideration is given to flowability, or even if w/c is kept constant. Here the widest possible range in flowability between the 1:2 and 1:8 proportions was observed with w/c constant. Modifying the mixtures to obtain equal flowabilities would have resulted in much greater differences in strengths than those obtained.

The tests included in Table VI (Fig. 5) are duplications of the concretes shown in Table 2, Bulletin No. 1, Lewis Institute, so far as duplication can be made in another laboratory. A part of this Table 2 is shown in parentheses. Instead of Elgin, Ill., aggregate, the local

Potomac River sand and gravel were used. The material was separated by screening on the various sieves and then recombined in the percentages shown in this table so as to have the same fineness modulus of 6.04.

Using cement from the same lot with eight of these aggregates numbered in Table VII to correspond with the numbers in Lewis Institute Table 2, batches of one part cement to five parts of aggregate were mixed in a batch mixer with the quantity of water specified by the formula for a 1: 5 proportion, modulus 6.04, and molded into 6 x 12-in. cylinders. The 1.10% consistency was used, giving the same ratio for all aggregates with a value for w/c of 0.898. Five 6 x 12-in. cylinders were tested at the 28-day period with the results shown in Table VI.

The slight difference shown for square inches of surface area per gram of cement, between the figures given in the accompanying Table VI and Table 2 in Lewis Institute Bulletin No. 1, are probably due to our regarding the surface area of aggregate passing the 100-mesh sieve as equal to that of the particles retained, as was done by Mr. Edwards in his report.

The results shown for the slump test and the flowability test indicate the wide variation in flowability. After the slump test was made with aggregates 264 and 280 and no slump was found, the masses of concrete were picked up by hand and carried back to the mixer without losing their shape. Aggregates 40 and 271 were of a consistency suitable for reinforced-concrete construction. Aggregate 278 resulted in what would be termed a harsh-working concrete, apparently being too dry as measured by the cylinder slump test, but showing very good flowing qualities as indicated by the flowability test.

In Fig. 6 are photographs of the cylinder slump test on batches made with aggregates 271 and 274, respectively, showing the marked difference in consistency as shown by this test. There are also photographs of the vibrating plate test for flowability on concretes made with aggregates 278 and 274. The difference in the spread caused by the vibration of the plate can be plainly seen.

The results of Table VI fully confirm the results obtained for constant water-cement ratio as shown in Table IV both as to differences in flowabilities and strengths. The results also confirm the statement in Lewis Institute Bulletin No. 1 that there appears to be no direct relation between the surface area of the aggregate and the compressive strength of the concrete.

The tests here reported indicate that the discrepancy noted between our results and the results obtained by Professor Abrams and Mr. Edwards is due fundamentally to wide differences in the consistencies, or flowabilities, of the concrete mixtures. While we have found large variations in the strengths of different concretes in which the water-cement ratio is maintained constant, this is of secondary importance in view of the fact that the concretes as made were not of comparable consistencies.

In view of the potent influence of a small amount of mixing water on the strength of concrete, the proper testing of concrete in the laboratory requires that the desired consistency, or workability, or plasticity, or flowability (all here meaning the same thing) shall be definitely arrived at. The need for an apparatus capable of measuring this property with considerable accuracy now seems apparent, and we believe the development of such an apparatus is worthy of the concentrated effort of all who are engaged in the study and testing of concrete.

Conclusion

In the field "flowability" is a fundamental requirement in order that economy in construction and good workmanship may result. Increased flowability may be obtained by the use of more mixing water alone, or by the use of more cement or fine aggregate, which, in turn, will require an even larger quantity of water. Since flowability is obtained by the use of more water, which in turn tends to lower compressive strength, it is of the greatest importance that concretes as tested in the laboratory have the same flowabilities, otherwise they are not comparable. On any work there is some minimum condition of flowability which must be obtained, and an endeavor should be made to attain this same condition in the laboratory so far as possible.

That this same condition of flowability cannot be obtained if the water-cement ratio is to be kept constant is the basic criticism which we have to offer to the two theories under discussion. If w/c is kept constant, even for a given ratio of cement to aggregate, then the condition of equal flowability must be disregarded.

If, as we believe, flowability is a fundamental consideration, then w/c is only an incidental relation, which is the resultant of the more important factors, cement, aggregate, and flowability, and, in itself, is of no direct value to the engineer in proportioning concrete materials. The w/c relation considers only water and cement. From the results of the foregoing tests it is apparent that (1) flowability, (2) cement, and (3) aggregate are the three important factors to be considered in the proportioning of concrete mixtures. The proper flowability is essential for the economical handling and placing of the material; it is desirable to reduce the quantity of cement to a minimum for economy; and the choice of aggregate is usually limited, but can often be improved somewhat in quality at slight expense. Water, while an essential, is dependent entirely upon the above three factors.

Any method of proportioning concrete which can be generally applied must therefore take these variable factors into consideration, and, whatever the brand or quantity of cement, whatever the type, physical condition, or quantity of aggregate, flowability of the concrete must be considered, first and last, as of fundamental importance.

Aggregates Too Coarse in Bureau of Standards Tests

Most of the Aggregates Are of Unusual Gradings Which Were Advised Against in Use of Fineness-Modulus Method

By Duff A. Abrams

Professor in Charge of the Structural Materials Research Laboratory, Lewis Institute, Chicago

In THE following discussion of the tests by Messrs. Williams and Davis, little will be said with reference to the surface-area method of dealing with concrete mixtures proposed by Captain Edwards. My views on this subject, together with new test data, are to be presented in a later communication to *Engineering News-Record*. This discussion will refer only to such por-

tions of the Bureau of Standards report which deal with the water-ratio fineness modulus method of designing concrete mixtures which was developed in this laboratory.

The authors state that "studies now under way in the Bureau of Standards indicate that neither of these two methods insures what is most necessary in practical concrete work; that is, a proper flowability or workability." I do not see that there is any necessary relation between these methods and the flowability of the concrete. Any desired degree of flowability can be secured by methods which are well known to every practical concrete man: that is, by using more water, richer mixtures, different grading of aggregates, other methods of handling, or some combinations of these factors. What we have attempted to do is to bring out the basic principles of concrete mixtures in a way that would eliminate "rule-of-thumb" methods of dealing with materials and proportions, and to enable the engineer to "design" a concrete mixture and estimate the influence of given changes in the composition of the concrete.

It is true that the method proposed by Captain Edwards can be reduced to the relation between the water-ratio and the strength of concrete. However, there is a very important difference between the surface-area method and our own in that, according to my views, Captain Edwards' method does not give the proper quantity of water as between mixtures of different makeup. The algebraic proof given by the authors establishes nothing more than what Captain Edwards originally assumed; namely, that the strength of the concrete is constant for a constant surface area of aggregate, so long as the quantity of cement and water are based on surface area. It will be pointed out in my discussion of Captain Edwards' report that the uniform strength obtained in his sand-mortar tests was due to the fact that a constant water-ratio was used.

The importance of workability, or flowability, as the authors have termed it, has been fully realized and pointed out in all of the reports emanating from this laboratory. I agree that the slump test which we have used is not ideal, but I fail to see how the vibrating-plate method can be any improvement. It is different; but there must be numerous difficulties in the way of standardizing such a determination, and it would not lend itself to the requirements of field use as readily as the slump test on 6 x 12-in. cylinders. The authors have used the 3 x 6-in. cylinder in making most of their slump tests. It would not be expected, from our experience, that this size of cylinder would give dependable results. Apparently, the slump values are from a single determination. Not fewer than five tests should be used for this purpose when endeavoring to establish principles.

Tables Discussed in Detail

A brief discussion will be given of the tests in each of the tables. It is notable that in most of the tables the mixtures and gradings of aggregates are quite unusual and do not at all represent the type of concrete with which the engineer has to deal. It will be shown that in these tests the authors have disregarded two essential considerations pointed out repeatedly in our Bulletin No. 1, "Design of Concrete Mixtures," as follows: (1) The grading of the aggregate should not be too coarse for the quantity of cement used; (2) the concrete must be plastic. These requirements are mentioned by the Bureau of Standards' engineers, but they were entirely overlooked in planning the tests and making the specimens.

There is a great diversity in the form and size of test pieces used, consequently it is impossible to make any cross-comparisons, but each table must be studied separately. The results are, in general, the average of two or three specimens made from a single batch. In Table VI, five specimens were made. Our experience has shown that this method will not give concordant results. Practically all of our experimental work is based on the results of from 5 to 10 cylinders, each made from a separate batch on different days. Two to 5 specimens *from a single batch* are little more dependable than a single specimen. It is the *batches* that vary more than the specimens in a batch. This emphasizes the necessity of mixing as many batches as possible. In many instances the specimens used were of small size—probably too small to give good results with the size of aggregate used.

The concretes in Table II were of a freakish nature in four respects: (1) Very rich mixtures were used; (2) the aggregates were of sizes that are never used in concrete; (3) in the leaner mixtures the grading of the aggregate was too coarse for the quantity of cement; (4) the last two mixtures were too dry for proper workability. The coarsest gradings which are permissible with a given quantity of cement are given in Table 3 and Fig. 5 of our Bulletin No. 1. It is there shown that for a 1:2 mix with aggregate graded up to ¾ in. the highest permissible fineness modulus is 5.90, whereas the authors use 7.00. The water-ratio for the two leaner mixtures in this table is about 70% of that required in accordance with our water formula. If we eliminate the last two tests in this table. we find that the remaining four results of the standard sand mortars gave a mean variation from the average of 4.4 and 5.1% at 7 and 28 days, respectively. The corresponding values for the ¾-in. gravel are about 12 and 16%. The standard sand tests are as uniform as would be expected from the number of specimens made and the extremely rich mixtures used. However, the two groups of tests are not consistent in themselves. It is not clear why the gravel tests should give results entirely different from the standard sand tests, unless it can be attributed to the large size of the aggregate used in the 3 x 6-in. cylinders, or to some other variation in method.

In Table III we find again that the principles of using plastic mixtures and avoiding too coarse aggregates for the quantity of cement used have been entirely disregarded. All but the first test in the "constant water ratio" group are too dry, as shown in Table A herewith.

TABLE A. TESTS WITH CONSTANT WATER RATIO IN TABLE III OF WILLIAMS AND DAVIS PAPER

Aggregate No.	Fineness Modulus Used	Fineness Modulus Allowed	Water Ratio Used	Water Ratio Required	Remarks
61	6.00	4.70	0.62	0.60	Much too coarse
62	4.60	4.70	0.62	0.69	Little dry
63	3.20	3.10	0.62	0.79	Little too coarse; too dry
64	4.00	4.30	0.62	0.73	Dry
65	2.00	1.85	0.62	0.94	Little coarse; very dry
66	4.00	2.50	0.62	0.73	Much too coarse; too dry

The fineness modulus "allowed" is taken from our Bulletin No. 1. The water-ratio required was calculated from the water formula used in our tests. Only *one mixture* (62) out of the entire group of six can be considered normal concrete, and even in this instance the grading of the aggregate is freakish.

It will be noted that the water-ratios used under the "constant-flowability" tests show almost a constant increase over the quantities given by our water formula, which verifies the results of our slump tests. Since all of the mixes in this group are plastic, we would expect the strength to be reflected by the water-ratio, had it not been that four of the aggregate gradings were too coarse. The remaining two tests (62 and 64) show a satisfactory agreement between the water-ratio and strength. All of the aggregates in Table III were of a grading which would be termed "freakish." In No. 61 there is no material finer than the No. 8 sieve; in 62, 63 and 64 there is no material finer than the 48 sieve. In 65 a uniform size of aggregate is used, and in 66 practically all of the material is between the 14 and 28 sieves. These features are in addition to the consideration of being too coarse for the quantity of cement used. The conclusions of the authors based on these tests are entirely erroneous, since they failed to take into account the obvious limitations in the composition of the concrete.

In Table IV we find that two aggregate gradings are decidedly too coarse for the quantity of cement used, and six of the remainder are so near the border line that slight variations in manipulation of the concrete might make them too coarse. Aggregates 7 and 8 are decidedly freakish in that all material below the 48- or 28-mesh sieve is omitted. This may account for the low strengths, although in general such a result would not be expected from these gradings. If we consider the strengths secured from aggregates 1, 4, 5, 6 and 9, (which are the only ones approaching normal concrete mixtures) it will be found that the variation in strength is less than 5%, whereas in the same table the variation of two tests using the same aggregate (1) and same water-ratio is 10%. In other words, the tests which the authors have offered as proving the incorrectness of the water-ratio theory give only one-half the variation found in duplicate tests in the same group. Aggregate 4 gives practically duplicate tests which vary 8%. It will be noted also that the tests given for "constant flowability" show a greater variation in slump than do the tests under "constant water-ratio."

The tests reported in Table V are the average of two or three 2-in. cubes. In this group we find that concretes from aggregates 51, 55 and 58 are too coarse for the quantity of cement used, and too dry. The fineness-modulus value used throughout is 4.55, whereas our Bulletin No. 1 points out that the maximum value which may be used with the grading and mixture used with aggregate 51 gives a fineness modulus of 3.50; for aggregate 55, 3.10 and for aggregate 58, 3.60. In other words, there are only two tests out of the group that can be considered as giving usable strength results; both of these are approximately 1:2 mix. These two mixes having the same water-ratio give uniform strength, in spite of the wide variation in grading of the aggregate, as would be expected. The conclusions of the authors, based on these tests, are obviously erroneous.

Laboratory Variation Inexplicable

I am unable to offer an explanation for the strengths found by the authors in their Table VI, in which they have duplicated eight of the gradings used in Table 2 of our bulletin. Our tests gave uniform strengths, whereas the tests made by the Bureau of Standards are quite variable. It is possible the explanation may be found in the method of mixing the concrete. While the details of the mixing are not given, it seems probable that a batch of about 1 cu.ft. was mixed in a machine having a capacity of 5 or 6 cu.ft. Considerable experience in our own laboratory has indicated that single batches of machine-mixed concrete are likely to be erratic. This would be especially true of fractional batches which were probably used in this case. [The Bureau of Standards tests in Table VI were made from concrete taken from a full machine batch. The smaller specimens in their other tables were hand-mixed.—Editor.] It should be pointed out that the gradings used in our tests were somewhat too coarse. Subsequent experiments led us to recommend the use of 5.80 fineness modulus for the size of aggregate and mix used in this group. A slight variation in the methods of manipulation might throw these mixtures into the region where they would be too coarse.

The authors have misunderstood the statement in our Bulletin No. 1 concerning the comparison between 1:9 and 1:2 mix so far as strength is concerned. My purpose in making this comparison was to bring out the fact that the strength of the concrete has no necessary relation to the quantity of cement used. Our tests did not give uniform workability; on the other hand, the workability was very different. Nor was the aggregate of the same size or grading. The tests did, however, bring out emphatically the essential dependence of strength on the water-ratio, which is quite contrary to the statements found in most of the textbooks, to the effect that the strength of the concrete is proportional to the amount of cement used.

It will be of interest to study the mixtures used with reference to the gradings of aggregates and consistency of concrete. Table B herewith gives the result of such a study. The tests in Table VI are omitted from this discussion, since the aggregates were duplicates of certain gradings used in our tests. Over 40% of the aggregates were too coarse for the quantity of cement used; 26% of the mixes were too dry; 21% were both too coarse and too dry; 72% of the aggregates were of "freakish" grading.

TABLE B. COMPARISON OF MIXTURES IN TABLES II TO V, WILLIAMS AND DAVIS PAPER

	Number of Mixes Falling in Each Group					
					Freak	
Table	In Table	Too Coarse	Too Dry	Too Coarse and too Dry	Mix	Grading
II	12	4	4	4	8	12
III	12	8	5	3	? (1-3)	12
IV	18	4	0	0	? (1-3)	6
V	5	3	3	3	.....	4
Total	47	19	12	10	.....	34

Freak mixtures and gradings should not give results essentially at variance with fundamental principles. There is no reason to expect that mixes which are much too dry for plasticity will follow definite laws. Such tests should not be cited as establishing the errors of principles which are based on thousands of tests of concretes of normal composition. It has been pointed out that in the majority of instances the grading of the aggregate was too coarse for the quantity of cement used, and in a large number of instances the mixtures were too dry. In some instances concrete suffered from both of these ailments. In view of the shortcomings mentioned above, the tests reported by the Bureau of Standards cannot be interpreted as a serious criticism of the methods of design of concrete mixtures developed by this laboratory.

Large Construction Companies Shun Road Work

Politics, Narrow Business Practices and Petty Contract Restrictions Are Objectionable to Construction Managers of Large Affairs

By C. S. Hill
Associate Editor, "Engineering News-Record"

Roadbuilding is now the largest single task before the construction industry of the United States. Unless the leaders of this industry as well as the rank and file of contractors who have for the most part, and also most capably, performed the lesser tasks of preceding road programs, shall array themselves with Federal, state and community officials to advance this task, its accomplishment will be retarded. How large construction organizations regard road construction as an opportunity for employment is, therefore, a question of vital importance. The answer, as it appears after careful inquiry and conferences with directors of such organizations, is presented in the article and discussion which follow—Editor.

TO EXPEDITE the enormous program of construction which confronts them, public road officials need to enlist the services of large construction organizations —those organizations which heretofore have perceived nothing that offered profitable occupation of their resources in the small isolated-contract method of doing road work. A favorable conjunction of circumstances has placed these contractors for a time at the call of road officials. Large hydraulic developments and heavy railway, bridge and foundation work have been stopped. Until they start again, contractors who have looked to them for employment will turn to road work. It depends upon the acumen of road officials whether they continue in road work. Candidly, the likelihood that they will is not too promising.

Large contracting organizations cannot be permanently interested in road construction, unless they can be assured contracts of sufficient magnitude to command their full resources, and unless they be accorded the broadminded consideration in road work to which they have been accustomed in work for private corporations. With these inducements lacking, those large contractors who have for the moment exhibited an interest in road construction will withdraw to their old lines of enterprise as soon as bridge, railway, foundation work and kindred kinds of heavy construction resume their pre-war activity.

Character of Business Relationship

The importance of large-mileage road contracts has been fully emphasized in *Engineering News-Record* of Mar. 13, 1919, p. 503, and of Apr. 24, 1919, p. 831. Little has been done anywhere, however, toward defining the new conditions which must be created in business relationship between contractors and highway officials. Diplomacy and, perhaps, to some extent, delicacy, have kept contractors from speaking frankly. We propose to do so here, but first it is desirable to understand the character of the business relationship between the large construction companies and their private-works clients.

Contractors who have grown great through successful construction for private industries are considered and treated by those interests as experts in construction and as men of affairs. The master-and-servant relationship has disappeared, and in its place has grown something akin to the relationship of partners in a mutual enterprise. A certain flexibility is a tacitly recognized factor of any formal agreement into which owner and contractor enter. Cognizance is given by both to possibilities which may readily arise and which may change the complexion of an agreement, and both stand prepared to concede modifications in prices and requirements where they are demanded by fair dealing and mutual justice. Honesty of intention is conceded by both parties to the agreement, and meticulous prescriptions to prevent either from overreaching the other are largely discarded.

These statements do not picture an imaginary relationship; it exists in its fullest measure between many well known contractors and their clients. All unusually successful contractors enjoy this relationship in great measure. That they do, and that the advantage is real, is evidenced by the fact that these contractors will generally bid lower on private than they will on public work.

Large Organizations Not Attracted

Stress is laid on this relationship between the large construction organization and its private-works clients, because it has an important bearing on the task of enlisting the service of these organizations in the road-construction industry. They are not greatly attracted by the opportunity as they appraise it. Some of the reasons, as given by contractors, can be briefed as follows:

Road construction has brought too many hardships upon contracting in the past few years. It has been directed with too little active sympathy with the contractor's difficulties.

Too great willingness has been shown to take advantage, at the expense of the contractor, of a rising price and wage market.

The practice of calling for bids merely to try out the market, with no intention of awarding contracts, is too common.

There is too common neglect to state them when limiting prices will rule.

Too great stress has been laid upon possibilities of dishonesty.

Bludgeon clauses are too many in road specifications.

Low prices often overshadow contracting experience and financial ability.

Too many road departments have attained a reputation for "breaking" contractors.

All of these accusations can be proved by example. There are too many to permit full elaboration of each, but it is worth while to consider a few and show how the large contracting organization, whose entry into road construction is being considered, is reacting to their influence.

Bludgeon clauses are perhaps no more common in road specifications than they are in the specifications for other pubic works, but they are frequent. That such a meaning of these clauses is intended will be denied. Consider, however, this clause: "Portions of the pavement showing voids in the concrete after finishing and removal of the side forms shall be rejected." Beyond

doubt the engineers who wrote this clause intend a fair and reasonable judgment on porous spots in the pavement edge. What, however, was the practical effect of the clause on the large construction organizations which bid on this specification? One firm did this: It assumed that existence of a porous spot entailed the removal of a day's run and made its estimates in accordance with this assumption. More broadly, the effect is this: Contractors who have built up a great business by honest workmanship, and who are accustomed to have their honesty conceded by managers of large enterprises, resent such clauses as indicative of an assumed necessity to prevent cheating, and regard them as convenient weapons in the hands of engineers and inspectors for holding up the work and imposing needless penalties.

Lowest-Price Slavery

Another reason why the large contracting organization regards road work with indifference when other work is to be had is that price has too great weight with the public roads official. If any bidder's price is right and his bonds are unquestionable, he obtains the work, no matter how unfavorably he may compare with the large organization in reliability, equipment, resources and all else which ordinarily are held to be assurance of a successful business transaction. No doubt, the road official is largely the slave of the law in this matter, but this does not alter the facts nor their effect on the large contractor. He demands a fair profit for his work because he expects to put all his resources behind his promise that the purchaser shall get what he has asked for in quality and speed of construction. This guarantee he considers worth paying for, and he has small patience with the kind of client who shops about for the lowest bidder and trusts to the security of his legal hold on the bidder to obtain acceptable work.

It is, perhaps, not a generous thought, but the large contractor wonders if the road official is not just now inquiring whether, in some way, he cannot unload his own burden of rising prices on the contractor. A great many road projects for which the people have appropriated money were predicated on pre-war prices. Now the road officials find that they cannot deliver the mileages promised. Their attacks on the price levels of materials have failed to obtain reductions. Shopping about for low bids is a possible way out of the dilemma in which they have been involved. Contractors are free to impute to the road official this disposition to shift his burden, and the thought does not add inducement to road contracting as an opportunity for the large construction organization to extend its business.

Large construction firms, when they make bids, demand reasonable assurance that it has been definitely decided to award contracts and to award them promptly. An occurrance of recent date illustrates what happens too often. Bids were called for and received on a job amounting to about $150,000. A well known, large company was the low bidder and expected the award of the work. Later it was learned that the decision to proceed with the improvement had not been definite, and, when the prices were seen, the road officials concluded that they "would not go ahead at present." In other cases limiting prices are determined but are not published in advance. The reaction of large construction companies to experiences of this kind is fairly indicated by one which asserted that it was "becoming disgusted with the whole road game."

Most of the large construction companies which contemplate embarking on road construction expect to equip themselves on a large scale. A season's work will not pay them for the investment which they contemplate; they must see ahead a number of years of activity. To be specific, one large organization in estimating for a recent letting figured upon spreading its original plant outlay over five years. It could not otherwise have named a price which would have had a chance of being accepted. Contractors who plan in this farsighted manner are the kind wanted in road contracting, but they frankly assert that they find little encouragement, in the attitude of road officials, for their broad planning. Road-construction plant is special plant. Few of its units are stock equipment of the general contractor who does railroad or heavy industrial work, and few of them can later be used in his general work. He must see the opportunity for continuous, profitable road contracting, or he cannot afford to invest in the special plant required.

Conclusion

Demonstration need not be carried further. If highway officials wish to enlist large general contractors in road construction, they can do so. Lacking normal outlets for action, these contractors are seeking opportunities in road construction. They will, for the moment, submit to the handicaps of road contracting. But if the road official wishes to retain these large organizations among the contractors at his command in prosecuting his large construction program, he must clear away the indictment which they have drawn against his methods. Let us be clear at this point. These large construction companies are not supplicating the road official to change his methods in their behalf. Indeed, they are, personally, very little concerned about his reform. Until he reforms, however, they shun extensive business transactions with him.

Suspected anxiety on the part of large contracting organizations to embark in road construction cannot be capitalized by road officials. There is no such anxiety. These organizations regard road construction merely as a possible but doubtful field. On the other hand, in the opinion of the contractors interviewed, the road official can proceed with success toward enlisting these organizations in road construction if he will: (1) Decide definitely before bids are asked that contracts are to be awarded, and then make awards promptly; (2) give weight to the contractor's resources and reputation for efficient work, instead of letting low price control; (3) adopt the practice of private industries in dealing with the contractor on a fair-price, good-construction basis, and (4) eradicate the practice of binding the contractor to honesty with meticulous, punitive restrictions, readily capable of being used unfairly against the contractor.

Designers of Louisville Lift-Bridge Machinery

Through oversight, the article in *Engineering News-Record*, May 22, 1919, p. 1007, describing the design of the new superstructure of the Louisville bridge, did not credit the firm of Waddell & Son, Inc., of Kansas City, Mo., and New York City, with the design of the towers and machinery of the 260-ft. lift span This firm acted as consulting engineers to the contractor.

Reline Mine Shaft on Steep Slope With Concrete

A Combination of Monolithic, Precast and Cement-Gun Methods Used in Old Shaft on Vermilion Iron Range

THE first steel-lined shaft sunk on the Vermilion iron range in Minnesota is being relined with monolithic concrete and precast-concrete lumber. This is the 1200-ft. Pioneer B shaft at Ely, Minn., which is on a slope of 70 degrees.

The sets forming the horizontal sections between which the vertical lath are placed were of 30-lb. steel rails, the lath being timber. Between some of the sets 1¼-in. wire cable was used, spaced on 6-in. centers, behind which timber was placed. On account of considerable wear and scaling of the rails, it was decided to secure a more rigid shaft by incasing the rails in concrete and putting in new steel dividers. The walls of the shaft are very irregular, so that the new concrete ranges in thickness from 4 to 24 inches.

For about 50 ft. from the top of the shaft, 3 x 10-in. concrete lath were placed between the sets, which are composed of 6-in. steel H-beams and are spaced 5 ft. on centers. Steel angles riveted on the inside of the sets hold the lath in position. Below this, to the 950-ft. level, the spacing of the sets is 4 ft., and the lining will be monolithic concrete. From the 1200-ft. level to the 950-ft. level, precast timbering was placed similar to that used for the first 50 ft. of the shaft.

Monolithic Concreting Continuous

Monolithic concreting was started from the 950-ft. level Oct. 1, 1917, and proceeded at the rate of about 50 ft. a week. Concrete is mixed in proportions of 1:5, the local, bank-run aggregate containing about 50% each of sand and stone. As much of the work was done in winter, a wooden shed was built, 28 x 112 ft. and 12 ft. high. The aggregate is brought in by teams, and men with wheelbarrows then carry the sand and stone up a runway to a ½-yd. mixer.

In order to make the work in the shaft continuous, a 1-yd. auxiliary hopper for concrete has been constructed at one side of the head of the shaft. The wooden box on the mine skip is easily able to hold 1 cu.yd. When it comes to the surface for concrete, the shaft face of the auxiliary hopper is opened by a lever, and the concrete slides into a box. After it is lowered into the shaft, a slide valve covering a hole 8 in. square at the bottom of the box is opened, and the concrete slides into the forms through a flexible 8-in. pipe having sections 4 ft. long.

The upper or hanging side, and the ends or short sides of the shaft, are thoroughly clean, as water is pouring down practically all of the time. With a little cleaning on the bottom side, the walls are ready for concreting. About 75% of the time is required to clean the walls, to fix the forms, place the reinforcement and arrange the bolts needed in the shaft forms. The remaining 25% is used in concreting. After an 8-ft. section is prepared it can be poured in one day. Wire-mesh reinforcement is used on the ends and hanging sides, being cut into 4-ft. lengths and so bent as to come within an inch of the face of the concrete.

In concreting, 12 sets of steel forms are used on the bottom sides, but wood forms are used on the ends and hanging side. These wood forms are being left in place. The sections of steel forms, alternately 3 ft. and 1 ft. high, allow for putting in the dividers, which are built of 3-in. channels, 5-in. H-beams and I-beams being the ladderway and skipway, while a 3-in. channel and I-beam form the dividers between the skipways. These dividers are placed directly above or below the old 30-lb. rail dividers.

An ingenious method is used in moving forms. A tugger hoist is rigged up on a post across the shaft in the ladder and pipe compartment, from which a rope guided by a ring on a trolley runs to a block and then down into the shaft. By the attaching of the end of the rope to hooks in the forms, the latter are easily handled and shifted.

Speed of concreting is limited by the mixer, which handles 8 cu.yd. an hour to the 1000-ft. level. As this is done only part of the day, only one crew is used at the surface, one man dumping raw materials into the mixer, one man handling cement from the stockhouse, three men on wheelbarrows, one man controlling the machine and handling the water.

Three shifts a day of four men each are used in the shaft. All of the men were specially picked for this work, being of a higher grade of intelligence than the usual run of mine laborer.

Steam is obtained from the mine boiler house, and the temperature in the shed is kept during cold weather at about 60°. A bare steam pipe along the wall helped to warm the stone and sand.

The cement-gun system is proposed for places where the hanging or upper side is only a few inches deep, as there is some question whether monolithic concrete of that thickness will adhere to the upper side of the shaft. Up to Jan. 1 the cement-gun had not been used, and for 100 ft. around the 700-ft. level the whole shaft was monolithic. On the bottom side the concrete extends an inch beyond the old steel rails, while on the hanging side and ends it extends ½ in. beyond the steel, giving a solid concrete face on all four sides. Plans for all this work were made in the Duluth office of the Oliver Iron Mining Company.

Comparison of Blows of Dull and Sharp Drill Points

ROCK drill points are the least effective and have the least penetrative results, blow for blow, when they strike the rock with most force and the shock is felt the most. This statement is made by Frank Richards in an article in *Engineering and Mining Journal* of Apr. 26, 1919, p. 735, where the apparent paradox is explained by the fact that with equal imparted energy the dull drill-bit is stopped more quickly than the sharp one. This the writer believes to be the cause of the breaking of many bits. A short abstract of the paper follows:

When impact is figured, the force of the blow struck is proportional to the suddenness with which the propelled mass is arrested. This may be clearly illustrated by the case of a reciprocating piston drill. Assume a drill with a piston 3 in. in diameter and a stroke of 6 in., and that in the working stroke of the piston it is driven the entire distance by an effective air pressure of 50 lb. per square inch. The area of the piston is almost 7 sq.in. As the assumed stroke of the piston is ½ ft., the resulting energy is $7 \times 50 \times \frac{1}{2} = 175$ ft.-lb.

The resistance will, of course, be greater in proportion as the distance in which the force is dissipated is shorter. Thus the resistance required to overcome 175 ft.-lb. of imparted energy would be 6 × 175, or 1050 lb., say 1000 lb., if the stoppage occurred within a distance of 1 in. Then, 4000 lb. of resistance would be required to stop the movement within ¼ in. and 16,000 lb. or eight tons, if within $\frac{1}{16}$ inch.

A penetration of $\frac{1}{16}$ in. approximates rock drilling conditions. Thus, at the rate of several hundred times a minute eight tons are applied and alternately stopped entirely. The rock strikes the bit with the same force as that with which the bit strikes the rock—the force must be precisely equal in each direction from the point of contact—and the greater the force at any instant with which the bit strikes the rock, the greater also must be the reacting force taken up in internal resistance in the body of the bit. The higher this reacting force the more likely it is that the bit will break.

Limit of Wear Should Be Fixed

Drills must wear, but the limit of permitted wear should be sharply defined, and systematic maintenance of bits in sharp condition should be recognized as the most profitable investment possible in connection with rock-cutting operations. In this connection power-drill sharpeners are to be commended as giving incomparably greater efficiency, as compared with hand sharpening.

The above theory was strikingly illustrated in a recent test, when it was found that the breakage in bits was very high, 10 bits being broken in a day's run. In every case it was found that the broken bits had become so dull as to lose their cutting power. In the next day's run care was taken to change the bit as soon as cuttings ceased to drop regularly from the hole. With this system it was found that no drill bit was broke in the day's run, with the exception of one dull bit which was used as a test and which broke within two minutes.

Highway Transport Engineering—a New Technical Field

Breadth of Training Necessary for the Transport Engineer—Many Problems to Be Solved—Suggested Course of Study

A BREADTH of training far more comprehensive than has been considered essential for many technical branches will be required for the proper equipment of the highway transport engineer, according to Prof. Arthur H. Blanchard, of Columbia University. In dealing with this topic before the annual meeting of the National Highway Traffic Association in New York, he outlined courses of study to be followed in preparing for this profession, linking them up with the problems which must be solved. Having sketched briefly the phenomenal expansion of highway improvement in highway transportation in the United States, and having contrasted the problems met with here with the experience in England, where highway-transport regulation came to a head some years ago, Professor Blanchard continued:

The development of highway transportation creates a demand for men having knowledge of and trained in a new technical field. Fundamentally, highway-transport engineering deals with the science, art, economics and business of the highway transportation of passengers and commodities. Breadth of knowledge is essential, as the highway-transport engineer must, in many fields, deal with social and economic conditions, and must always have before him the fundamentals of sound business methods.

In the opinion of some, highway transport may not be considered as belonging to the field of technical training and education. On sober thought, however, it will be seen that this branch of knowledge comes well within the classic definition of engineering embodied in the royal charter of the Institution of Civil Engineers of Great Britain, which, in part, is as follows: "The art of directing the great sources of power in nature for the use and convenience of man as the means of production and of traffic in states both for external and internal trade."

Comprehensive courses in highway-transport engineering to be offered by educational institutions should include the following basic subjects: Economics, political economy, social science, business and contract law, scientific management, business organization, cost accounting, interstate commerce and marketing and distributing systems.

What Highway-Transport Engineer or Manager Should Know

The highway-transport engineer or manager should have a knowledge of all of the following special subjects:

History of American transportation and rural development; English highway transport methods and legislation; interrelationship of highway, railway and waterway transportation, including influencing factors of distances, rates, kinds of freight and equipment; port, terminal and warehouse facilities; interrelationship of highway transport, good roads and rural development; the "back-to-the-farm" movement, which is a function of three fundamentals—namely, building of systems of good roads, utilization of highway transport, and establishment of economic distribution from producer to consumer.

He should also have a knowledge of the subjects under the following heads:

American Highway Traffic Legislation—National, state, county, township and municipal laws, licenses, taxes and traffic regulations, especially those covering speeds, weights and dimensions of motor trucks, trailers and motor buses.

Fundamentals of Highway Engineering Affecting Economic Highway Transport—Administration of highway departments; highway systems; location, drainage, foundations, grades, curves, widths and shoulders of highways; characteristics of different kinds of roadway, with particular reference to traction; snow removal; guard rails, culverts and bridges; highway signs.

American Highway Transport Methods—Comparison of horse and motor transport, municipal haulage, muncipal delivery systems, store-door delivery, intercity haulage, long and short haulage outside of cities, rural motor express, return-loads bureaus, motor-truck parcel post, plant and factory haulage, Army transport methods, horse transportation methods; efficient methods of packing, handling, loading and unloading raw and manufactured materials; highway transport management; fundamentals of cost of highway transport, cost and record systems; organization of motor-haulage companies; labor for highway transport.

Motor-truck, Motor-bus, Tractor and Trailer Mechanism, Operation, Inspection, Maintenance, Repairs and Cost Data—Adaptability of different types of trucks and bodies; disadvantages of overloading and overspeeding; economic utilization of tractors and trailers; garages; accessories, such as tires, fuels, lubricants and mechanical devices.

Transportation Surveys—Investigations of highway routes, highway-transport legislation, traffic regulations, rural and urban transportation opportunities, competing carriers, including railway, waterway and other highway-transport facilities, and all other factors which may affect the transportation business which it is intended to establish.

Engineering Standards Committee to Reorganize

Proposes to Become an "Association" to Include a Wider Field of Work — Membership Open to All Interested Bodies

A REVISED constitution was adopted by the American Engineering Standards Committee at a meeting held May 17. This new constitution has been submitted for ratification to the councils of the five societies which formed the committee, the American Society of Civil Engineers, the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers and the American Society for Testing Materials. The proposed reorganization developed from a meeting of organizations interested in formulating safety codes, held at Washington on Jan. 15, at which the American Engineering Standards Committee was described by its chairman, Prof. C. A. Adams, and a proposal was made to have the safety-code work carried on under the rules of the committee. It was objected, however, that the safety-code conference could hardly be expected to submit its work for approval to a committee on which its own members had no representation. In order, therefore, to bring about a form of organization with broader character of representation, the revision of the constitution was formulated.

Details of the contents of the new constitution are withheld by the committee. Essentially, the reorganization, which changes the name "committee" to "association," provides for increasing the body by taking in representatives from other organizations than the five founder societies and the three Government departments originally named, and fixes the dues of the societies represented. The new constitution also makes it optional with member societies to submit to the association for approval any or none of the standards which they may formulate. Commercial and scientific or non-commercial standards are governed by somewhat different rules concerning the constitution of committees.

Explanatory Statement by Committee

In announcing its action, the Engineering Standards Committee states:

It is anticipated that in nearly all cases the approval of standards and committees by the association will be requested. In case it is considered advisable, the association is authorized to call a meeting of those who would be interested in the formulation of a new standard or the revision of an old one, to select one or more sponsor societies. The sponsor society or societies will appoint a sectional committee to formulate or revise the standard. This sectional committee will report to the sponsor when its work is completed. The sponsor may then request the association to approve. The association deals only with the sponsor and acts only at its request.

In further explanation of the manner of action of the proposed association, it is stated:

The association thus acts only to bring together those interested in a common object, and, when they have completed their work will at their request certify that it has been done in such a manner as to justify its adoption. Nothing revolutionary is proposed; it is merely an extension of present practice. The executive committee of the American Society for Testing Materials now passes on the composition of committees, ascertains that their conclusions are substantially unanimous, and, if so, reports them to the society for acceptance or rejection. The association does the same for groups of organizations. Its board of directors performs the same functions as the executive committee of the American Society for Testing Materials, and the association as a whole accepts or rejects. It neither selects sponsors nor sectional committees; it does not consider the subject matter of a standard, nor the procedure under which it is arrived at, except that it requires sufficient information from the sponsor to show that the conclusions are substantially unanimous and that the sectional committee is balanced and representative.

It may be asked whether there is sufficient reason for the existence of the association. This, naturally, has been carefully considered, and it is the unanimous conclusion of the committee and of all those who have been consulted who have been active in standardization work that such an organization is urgently needed. In the past there have been many occasions when two or more organizations have formulated standards for substantially the same thing. Often these differences have been very slight, but neither has been quite acceptable to the other party. In the majority of such cases, if these organizations had been brought together at the start they could have agreed on a standard that would have been satisfactory to both. The American Engineering Standards Association will furnish a means by which any organization intending to define a standard can readily ascertain what others are interested, and should be consulted in regard to it. At present there is no such means.

Expect Present Organizations To Ask Assistance

There is nowhere anything approaching a complete list of the organizations doing standardization work, much less any list of the standards proposed or in preparation. The enormous advantage of having any standard generally accepted, and the much greater probability of accomplishing this if it is prepared under definite conditions that have proved effective in the past, will, it is believed, cause most of the organizations engaged in such work to ask and receive the assistance of the American Engineering Standards Association. It provides definite machinery for securing coöperation and preventing duplication of work. It establishes definite rules securing the absolute autonomy of any group engaged in the development of standards, and insures that this group shall receive full credit for its work. With the assurances of coöperation that the American Engineering Standards Association has already received, we believe that there is no question of the advisability of forming the more broadly representative association. Several organizations have already presented requests for the approval of existing standards, and we are informed that many others only await the notification of the committee that it is fully organized

It has been impossible to make any public statement of the committee's plans until they had been definitely formulated. This, we feel, has now been accomplished, and we can therefore state what it is hoped to accomplish and the methods proposed for the purpose.

G. C. Stone, vice-chairman of the committee, is directing its work for the time being. C. B. Le Page, 29 W. 39th St., New York City, is acting secretary.

Class in Art for Engineers

According to the *Bulletin* of the Art Institute of Chicago, a member, who is an engineer by profession and the head of a large engineering company in Chicago, came to the institute over a year ago with the desire that a class be formed for the men in his office, that they might become familiar with the collections in the Art Museum and develop a love of and desire for beauty. This course held an interested group and has just been organized for another year, meeting weekly, with attendance voluntary, the extra time being made up at the end of the day.

Mechanical Handling the Feature of Concrete Pile Yard

At Norfolk Army Base Both Bearing and Sheet Piles Were Rapidly Turned Out in Plant at Which Manual Labor Was Reduced to a Minimum—Concrete Mixed Alongside Each Pile

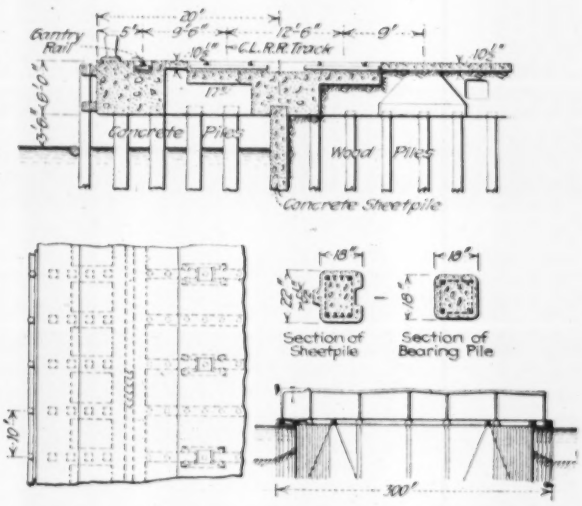
OVER 7000 reinforced-concrete bearing and sheet piles had to be cast in the summer of 1918 for the Norfolk Army supply base. In order to insure the completion of the contract in the short time allotted, there was built at the site a special pile-casting yard of extraordinary elaboration and size, and the casting was completed there in the required time. In all, there were cast 7442 piles, using 35,200 cu.yd. of concrete and 6400 tons of reinforcing steel, in the four months during which the plant was in operation. The highest number of piles cast in a 10-hour shift was 141, representing 620 cu.yd. of concrete. Every advantage was taken to substitute mechanical handling for manual labor.

The Norfolk Army supply base has as an integral part two piers, each 300 ft. wide and 1328 ft. long. On account of the nature of the ground and as a protection against the teredo which infests those waters, the type of section shown in the accompanying drawing was adopted. This, it will be seen, comprises a fill over the middle 260 ft. of the pier, retained by reinforced-concrete sheet piles, with wooden piles in the fill portion and an extension platform, carrying a gantry crane, with reinforced-concrete bearing piles. There were, therefore, two types of concrete piles to be cast, a rectangular tongue-and-groove sheet pile 18 x 22 in. in section, and a bearing pile 18 in. square.

The sheet piles varied by 5-ft. increments in length from 35 to 65 ft., while the bearing piles varied from 50 to 65 ft. Special sheet piles were also cast, consisting of corner piles, double-tongue and double-groove piles, closure piles 15 in. wide, and wedge piles narrowing from 18 in. at the top to 9 in. at the bottom. The bottom of the sheet piles was beveled 6 in. in 2 ft. on the groove side to facilitate crowding the piles together, and the bottom of the bearing piles tapered in 8 ft. from their full section to 10 in. square. The reinforcement consisted of a 1¼-in. deformed bar in each corner with ¼-in. hoops, spaced as required in the design. Additional reinforcing bars were used to take care of stresses set up by the methods that were required in handling the piles, the length and size of the bars depending upon the length and weight of the piles.

Two Yards Had to Be Built

A number of views of the yard in which the piles were cast are shown, as well as a drawing of the layout. As shown on the sketch, there were two yards, an east yard and a west yard, on either side of a central main-line track from which the aggregate was delivered. The details of the two yards were somewhat different, but in both every effort was made to magnify the use of machinery on account of the labor shortage at the time when the work was carried out. Both yards are laid out in a straight line controlled by straight tracks running parallel to the main delivery track. In the east yard the steel-fabricating shed was at one side of the yard, delivering reinforcement to the forms on the concreting platform. In the west yard the steel-fabricating shed was at the extreme end of the yard. In the east yard the steel and the finished piles were handled from a steel gantry crane spanning the casting platform. In the west yard this work was done by a locomotive crane. Both yards used a traveling concreting bridge, but the east yard had its aggregate fed from an aggregate car traveling on a track from the storage bins, whereas in the west yard there was a plank runway on which man-handled wheelbarrows transported the aggregate. The entire casting yard is about a mile from the water front on a comparatively level area. The foundation

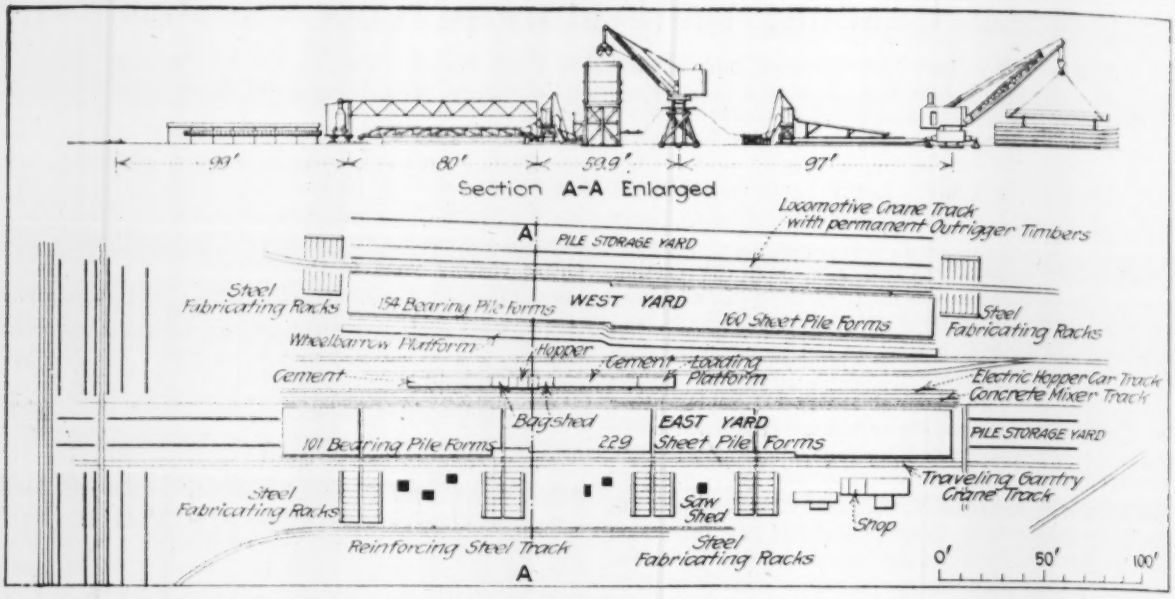


DETAILS OF CONCRETE PILES USED ON THE PIERS OF THE NORFOLK ARMY SUPPLY BASE

upon which the forms were built was substantial and unyielding, which permitted the casting of the piles very straight and true.

The reinforcement was fabricated on special racks in the sheds alongside the pile yards. These racks, as shown in one of the views, were placed about 4 ft. above the ground and were supported on 2 x 4-in. stakes and stringers. Strap iron was laid on top of the stringers to facilitate the movement of the steel without unduly wearing the supports. Fabrication was carried on under the shed on cantilevered brackets raised to such a height as to carry the two upper rods the proper distance above the runway stringers. When necessary, these longitudinal rods were spliced together and thoroughly wired after splicing. The ¼-in. hoops were then swung into place and fastened to the longitudinal rods, using No. 12-gage annealed iron wire or a special connection. When the reinforcement was finally fabricated it was pushed off the brackets onto the stringer and slid along until it reached the ends of the racks.

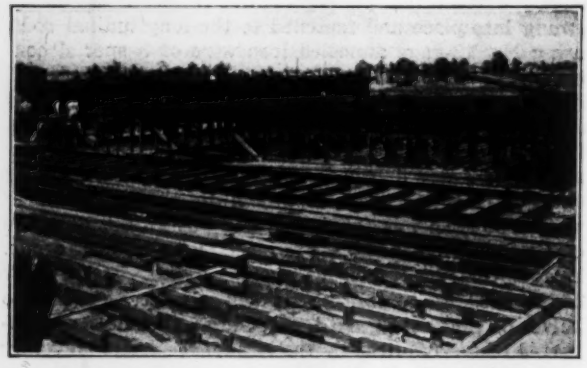
In the east yard fabricating shed the assembled reinforcement was dropped onto a long flat truck running on a narrow-gage track parallel to the direction in which the steel was fabricated and pushed out onto the casting platform, to be set in place by the gantry crane. In the west yard shed, as shown in the general view of the yard, a standard-gage track ran between the two halves of the casting shed, and the steel could be transported where required by the locomotive crane traveling on the track. A rigid beam with multiple supports was used in lifting the steel.



GENERAL LAYOUT OF CONCRETE PILE-CASTING YARD AT NORFOLK ARMY SUPPLY BASE

The forms in both yards were of cut lumber resting on continuous fills. The bottom forms were stationary, and the side forms were set and wedged at the bottom as required, the tops being set to line with templets, and 1 x 2-in. nailing strips were nailed on top of the forms to keep them from moving. In the east yard the casting platform on which these forms were placed had on either side a single rail and a track which carried, respectively, a pile-handling gantry of steel framing and a wooden concreting bridge.

The operation of concreting in this yard was carried on about as follows: The material was brought in on the main track, and the sand and gravel unloaded from an elevated trestle by gravity. A locomotive crane operating on this trestle lifted the sand and gravel from the ground where it had been dumped to the bins alongside of the east yard. From these bins the material was deposited by gravity to a measuring hopper, where the proper proportions of sand and coarse aggregate were measured and mixed, and from these measuring bins the coarse aggregate ran by gravity into a special aggregate car which traveled on a track running alongside of the aggregate storage bin. This car was run by electricity to the mixer, which was also moved on a parallel track and which was at the time of concreting placed immediately opposite the pile to be poured. Over this pile was the concreting bridge. The batch in the aggregate car was run by gravity into the skip of the mixer and there mixed. After being mixed the concrete ran by gravity into the car supported on the concreting bridge which ran immediately over the pile. This car had a bottom-drop door through which the concrete was deposited at any point in the length of the pile.



REINFORCEMENT FOR PILES WAS FABRICATED UNDER SHED AND MOVED TO CENTRAL TRACK

This method of handling the material permitted the concrete to be mixed immediately over one end of the pile, and there was no danger of the aggregate becoming separated by reason of transporting the concrete a long distance. As the yard was over 1800 ft. long this difficulty in so hot a climate in the summer would have been very hard to overcome. By the method employed the concrete could be deposited in a very few seconds after it was out of the mixer.

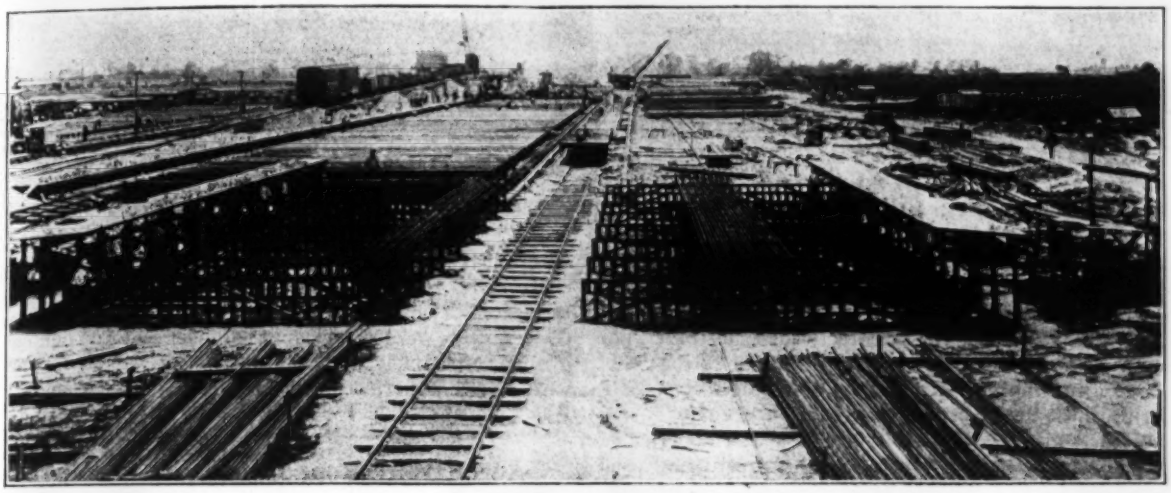
The electric-driven hopper car, which delivered the dry batch from the central hopper to the mixer, consisted of a hopper which discharged directly into the loading skip of the mixer. It was mounted on trucks, and the motive power was furnished by a 15-hp. motor geared to one axle, and with a street-car motor control. The mixer was mounted on a car which was moved along by a rope from a hoisting engine or by use of a pinch-bar. The two wooden concreting bridges, with a span sufficient to cover the longest pile, were designed and made on the work to carry the concrete car the full length of the pile. The trusses were built of timber and rods.

After the piles were cast they were handled by one of the two steel gantry cranes, which were propelled by a three-drum hoisting engine mounted on a car at one end of the pile. Two drums were used to pull the car and the gantry back and forth. The third drum was used to raise and lower the pile, the rope being reeved through a series of tackles which lifted the beam at four points. Adjustments were made at each of the four points by means of turnbuckles. The beam was made up of two 18-in. I-beams with their flanges riveted together.

Cement was handled in different manners. Wherever possible it was used directly from the cars to the dry-batch car, in order to avoid rehandling, but a cement house was provided holding a number of cars of cement as an emergency to take care of any situation.

In the west yard, which was built after the east in order to increase the output on account of the developing program of construction, additional gantry cranes were not available, so the work of handling the reinforcement and the finished piles was taken care of by a 150-ton locomotive crane mounted on a standard-gage railroad track. In this yard no piles longer than 55 ft. were cast. The mixing plant consisted of two ¾-yd. mixers, one driven by steam and one by electricity, mounted on elevated trucks traveling on a standard-gage track.

The steam mixer discharged into an inclined chute with removable bottom section, the chute being mounted on 4-in. cast-iron casters traveling on a movable plank track. The electric mixer had a concrete bridge and bottom-dump bucket, similar to those used in the eastern yard, except that, being shorter, this one was built as a unit with the mixer truck and traveled with it. Both mixers were served with concrete material by wheelbarrows operated on a track runway about 5 ft. high along the edge of the storage pile. Cement was used directly from cars when possible, or was delivered by wheelbarrows from the east yard cement shed through two alleys left for that purpose in the storage pile. In the west yard the locomotive crane handled the finished piles to the pile storage on the other side of the track.

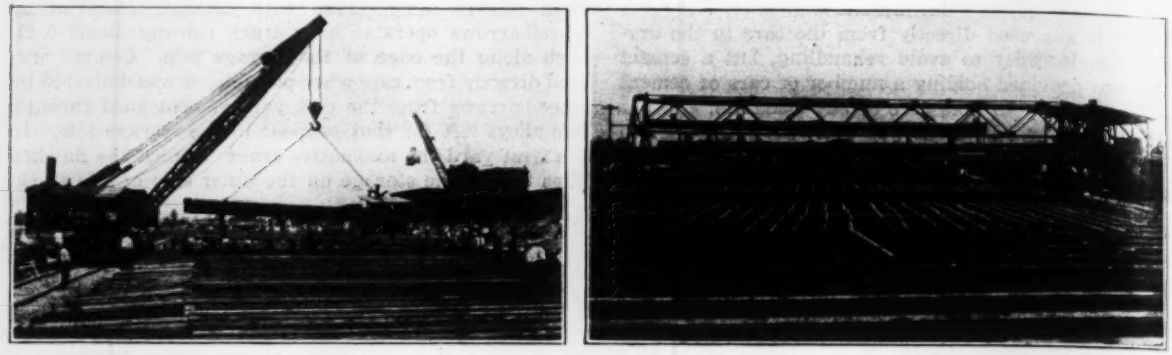


LOOKING DOWN LOCOMOTIVE-CRANE TRACK IN WEST YARD; FABRICATING RACKS IN THE FOREGROUND. AGGREGATE TRESTLE IS AT THE LEFT

The storage yard for the curing of piles was carefully prepared, in order to prevent damage to the piles due to uneven settlement. Two rows of standard railroad ties were set 2½ ft. c. to c. on a graded bed. On these ties continuous 6 x 12-in. timbers laid on the flat were placed about 36 ft. c. to c., or about under the pile-lifting point. Piles were usually stacked on these timbers four high with the gantry cranes and five high with the locomotive cranes. There was about 4-in. clearance between the stacks of piles, and successive layers of piles were separated by 3-in. timbers laid on the flat.

During exceedingly hot weather the piles were sprinkled while in the storage yard, to aid in curing. The storage period was about three weeks, although

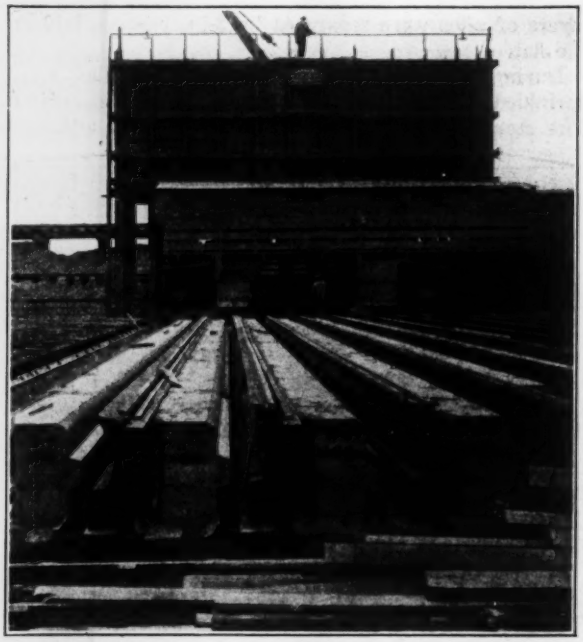
LOOKING DOWN CENTER OF PILE-CASTING YARD; EAST YARD AT RIGHT, WEST YARD AT LEFT. AGGREGATE TRACKS IN CENTER



HANDLING PILE WITH LOCOMOTIVE CRANE IN WEST YARD; WITH STEEL GANTRY IN EAST YARD

many piles were driven successfully in 14 days, and in the case of wedge piles they were driven in seven days without any damage whatever. In transporting the piles to the work they were loaded on heavy, steel-body flat-cars of 80-ton capacity, five or six to the car. The usual trainload consisted of three loaded and four idler cars. Some of the piles weigh as much as 13 tons.

Owing to the great demand by Government improvements in the neighborhood for coarse aggregate, it was necessary to use different kinds of material, crushed granite, limestone, and washed bank gravel being used at various times, but all in the proportion of 1:1½:3. On account of the small space between the reinforcement and the forms, it was necessary to use a stone of small size, the best result being obtained by a maximum diameter of 1 in. The bulk of the fine aggregate was coarse, washed bank sand. The workmanship in connection with the placing of the concrete was very thorough. Spading was continually carried on, and no expense was spared to be sure of good quality of concrete. Running it too Wet was not permitted, because the concrete was deposited from the car immediately above the place where it was required.



HEAVY CONCRETE SHEETPILES ON CASTING PLATFORM

Electric-driven aggregate cars in background in front of material storage bins.

The work was done by the Raymond Concrete Pile Co., of New York, for the United States Government, with Porter Bros., of Wilkes-Barre, Penn., as general contractors. Col. M. A. Butler was constructing quartermaster in charge of the work and A. O. Leach and G. F. Bowlus were supervising engineer and division engineer, respectively, for the Government. A. F. Barnes was general superintendent for the Raymond Concrete Pile Company.

Aerial Wire-Rope Conveyors to Feed Railways and Ships

IN SPEAKING on the value of "Aërial Wire Rope Conveyors as Feeders for Railway and Ship Lines," before the engineering section of the Pan-American Commercial Conference, Walter C. Kretz dwelt on their ability in developing regions at present inaccessible, on the west coast of South America. In his opinion they will solve many difficult and, in fact, otherwise unsolvable problems of transportation in that region.

After giving a description of the various types of aërial cableway, together with the limitations of each, he cited examples of their successful use under South American conditions.

One advantage of cableways over other means of transportation is that they can operate over very steep grades. An installation in Africa was mentioned which is operating over an 86% grade. Principal among the examples described is one in the Argentine Republic. It extends from the end of the railway line at Chilicito to Upulungos, a mining town 34.67 km. (21.5 miles) away, and 3510 m. (11,513 ft.) higher in elevation. On the down trip it carries chiefly ore, at the rate of 40 tons per hour. Passengers, miscellaneous supplies, machinery, etc., are also transported in both directions.

According to Mr. Kertz, this installation is at present the longest aërial cableway in operation in the world. It has nine separate sections, with intermediate terminals where transfer from one section to the other is made automatically.

Ship loading and unloading in open roadsteads, by means of building an island pier well out and transferring the passengers and freight by means of cableways, were also touched upon.

The speaker said that it must not be thought, because the installation is cableway, that it can be built for the mere cost of the cable and engines. It is doubtful if any such installation can be made for less than $10 per meter (3.28 feet).

Labor Turnover High on Two War-Time Contract Jobs

Short Average Stay of Both Skilled and Unskilled Laborers Decreased Efficiency and Increased Cost of Work

By Sidney G. Koon
Walter B. Snow and Staff, Boston, Mass.

FLOATING labor undoubtedly contributed much to the difficulties of war-time construction noted by H. C. Turner in his article in *Engineering News-Record*, of Apr. 24, 1919, p. 815, if the experiences of most contractors was the same as that of the Aberthaw Construction Co., of Boston, on two large Government contracts, as well as their experience through 1917, on work of which none was done for the Government. All of these jobs, Government and otherwise, were done on the cost-plus basis.

An analysis of the labor situation on 15 jobs (in three states), which were started and completed in 1917, shows a total of 7179 men hired; while the sum of the 15 separate peaks, showing the maximum number of men on a job, was only 2812. The ratio between the number of men hired and the sum of the 15 peaks is 2.54 to 1—or, in other words, five men were hired for every two men at time of greatest employment. More than two-thirds of all the men who left of their own accord simply quit without giving any reason.

Taking the whole experiences of the year in connection with the length of time during which individual men worked on a job, it is found that 18.9% of the men worked three days or less; 32.4% (practically one-third) worked not more than one week. More than two-thirds of the total, 68.3%, were on the job less than one month. Of the total number employed, the "exits" were distributed as follows:

Transferred to other jobs		1882
Quit, no reason given	2174	
Left for another job	321	
Left because of sickness	139	
Left for family reasons	91	
Dissatisfied with job	78	
Leaving town	120	
Gave notice	51	
Dissatisfied with pay	38	
Enlisted or drafted	103	
All other reasons	91	
Total resigned		3206
Dismissed as incompetent	415	
Refused to obey	95	
Trouble-makers	23	
Drunk	14	
Not adapted to work	17	
Refused to work	73	
Struck for higher wages	12	
All other reasons	148	
Total dismissed		797
Laid off on reducing force	290	
Laid off, no stock	10	
Laid off, job finished	994	
Total laid off		1294
		7179

Divided according to length of service on the job, the men were grouped as follows:

3 days or under	1351
4 to 6 days	980
7 days to 2 weeks	1359
2 to 4 weeks	1219
4 to 6 weeks	750
6 to 8 weeks	458
More than 2 months	1062
Total	7179

A more detailed analysis has been made of the work at the two jobs listed below, both of which were for the Government and both carried on under high pressure.

At the Squantum works of the Bethlehem Shipbuilding Corporation, Ltd., where the Aberthaw Construction Co. erected in record time the largest destroyer-building plant in the world, the job was started in the second week of October, 1917, and was practically finished in June, 1918. About $13,000,000 was spent in providing a complete plant with 10 building ways. There was no war construction work going on in Boston, and the district had an excellent labor supply. For the first 10 weeks the men had to walk from 15 to 25 minutes from the nearest railroad or trolley line to get to the job. This was during the early part of an exceptionally severe winter, the daily mean temperature during January never going above the freezing point. A total of 10,300 men was hired on this job. The employment peak, Jan. 12, was 4200 men, showing a relation of the total number to the peak of 2.48 to 1. It will be noted that this is almost identical with the experience of the company on the 15 non-war contracts of 1917.

Of the total number of men employed, 3050 (29.6%) quit in one week or less; 2078 (20.2%) quit in seven days to one month; 1600 (15.5%) quit during the second month of employment; 1209 (11.7%) during the third month, and smaller numbers during succeeding months. These figures show that 77% of all the men hired for the job were gone in three months.

Of the total number of men hired 6219 were laborers; 31% of these, or 1936 men, worked one week or less, and nearly 55% (3344) worked not to exceed one month. The record of the laborers is thus seen to be somewhat worse than that of the men as a whole. In fact, if we deduct the number of laborers from the total number of men, we find that 1114 of the 4081 other men quit during the first week, this being 27.4% as compared with 31% for the laborers. Similarly, 43.6% of the higher-grade men had left the job inside of the first month of employment, as compared with 54.8% of the laborers.

Maryland Shipyard Had Worst Labor Turnover

The $3,000,000 job at Sparrows Point, also built by Aberthaw, 14 miles out of Baltimore, showed a radical difference in turnover of labor. The total number of men hired was 5245, of whom 3562, or 67.9%, had quit at the end of the first week of employment. Additional men to the number of 1070 left before the first month elapsed. This total is no less than 88.3%, by far the worst labor mortality in the history of the Aberthaw company. The number of men on the day of the peak was 836. The ratio of the total number hired to the peak number was 6.27 to 1, practically double the highest of any figure reached among the 1917 contracts.

The Sparrows Point job was started in June, 1918, and ended in February, 1919. It was in a district in which war contracts totaling many millions were under way, and was at the extreme end of the railroad line running out from Baltimore, which passed seven other large contract jobs. Camp Holabird was the nearest to Baltimore; in succession a munitions plant, a large sewer, water and gas contract, two Government housing projects and two Government shipyards were passed before the Sparrows Point job was reached. On the last-named four contracts, free transportation to and from Baltimore was furnished; but this was not the case on the Aberthaw job. Consequently a barracks was built and a restaurant established on the job to take care of the men who were not residents of Baltimore.

The Baltimore district reported a constant shortage of labor because of the large number of projects under way in the vicinity, and the United States Employment Service, from which the laborers for the Aberthaw job were obtained, had to serve the insistent demands of all. By the time laborers reached Sparrows Point they had made the rounds of every construction job in the district.

From the above cases it will be noted that the work at Squantum, with bad transportation and exceptionally severe weather conditions, was a little better than the average job with regard to labor turnover. This was unquestionably due to an adequate supply of common labor in a populous district where there was little emergency call for labor. Sparrows Point, on the other hand, with much better transportation conditions and better weather, but with an extremely deficient labor market, both as to quantity and quality, produced an exceptionally poor record. The laborers obtained on this job (with the exception of two gangs aggregating 264 picked men who were shipped to the job from Boston direct) were obtained through the Government employment service. Addresses on the employment cards showed that they came from six foreign nations and all but eight of the states of the Union. There is no reason to suppose that any other condition would have obtained had this job been on a lump-sum basis instead of the cost-plus which prevailed.

Influenza in Families Made Men Quit

Less than 19% of the men taken to the job from Boston had quit at the end of the first month of employment, as compared with 93% of the total laborers hired on the job. Even this 19% was higher than would normally have been the case, because a considerable number of men left for home on account of the influenza epidemic in Boston, which affected many of their families.

In tabular form the experience of the Aberthaw Construction Co. on these two jobs may be set down as follows:

Job	Total Number Hired	Men at Employment Peak	Ratio	Per Cent. Quit in — Not Over One Week	Not Over One Month
Squantum	10,300	4,200	2.48	29.6	49.8
Sparrows Point	5,245	836	6.27	67.9	88.3

Job	Total Laborers Hired	Laborers on Day of Peak	Ratio	Per Cent. Quit in — Not Over One Week	Not Over One Month
Squantum	6,219	2,688	2.31	31.0	54.8
Sparrows Point	3,017	334	9.03	77.0	93.0

It must not be imagined that these employment figures at Sparrows Point were in any degree due to neglect or lack of adequate supervision. The superintendence, office men and foremen, all were the pick of the organization, and no effort was spared to make the work go smoothly. But the men available were simply "not there." The superintendent estimated the general average efficiency of the men on the job at less than 40%, as compared with 80% for the average on a good pre-war contract, both based on the observed qualities of the best men on the work.

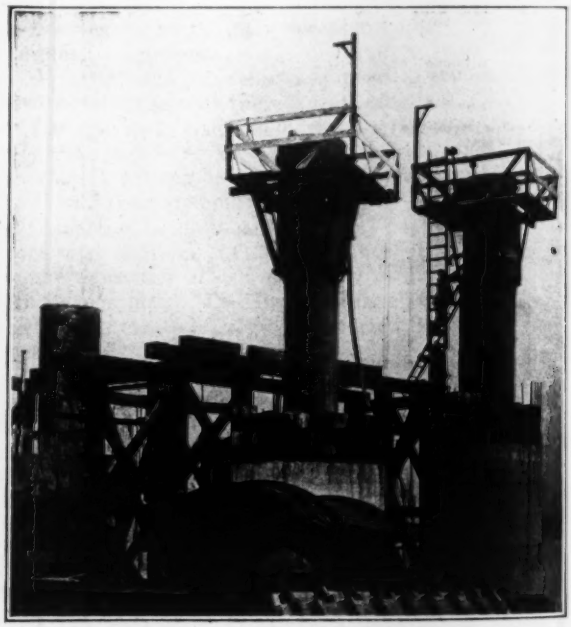
On the basis of an analysis which is as yet incomplete, no marked difference is shown in the percentage of men quitting, whether they are single or married. The question of family responsibility seems to have had little effect, probably because there was always a superabundance of work of one sort or another to which a man could turn any time he had a grouch or felt inclined to wander.

The problem is a very acute one, which will well repay the closest attention and most careful investigation of all employment managers, in hopes of finding some means of overcoming the evil of having constantly to train new men to a job for which an adequate number of men had already been trained. It is a problem which is never so prominent in times when labor is plentiful and jobs are relatively scarce, but it has such a large bearing on costs that anything which can be done to ameliorate the condition will be highly welcome. Once the main causes of dissatisfaction are localized and the proper remedy applied, there should follow quickly a more stable labor condition, with consequent benefit both in costs and in time of construction. This would help everybody alike, laborer, contractor, and owner, but the task of finding the answer is peculiarly one for the contractor alone.

Pneumatic Caissons Sunk Through Moving Ground

Constant Movement of the Earth Necessitates Suspension of Tower Foundation Piers From Overhead Timber Frames

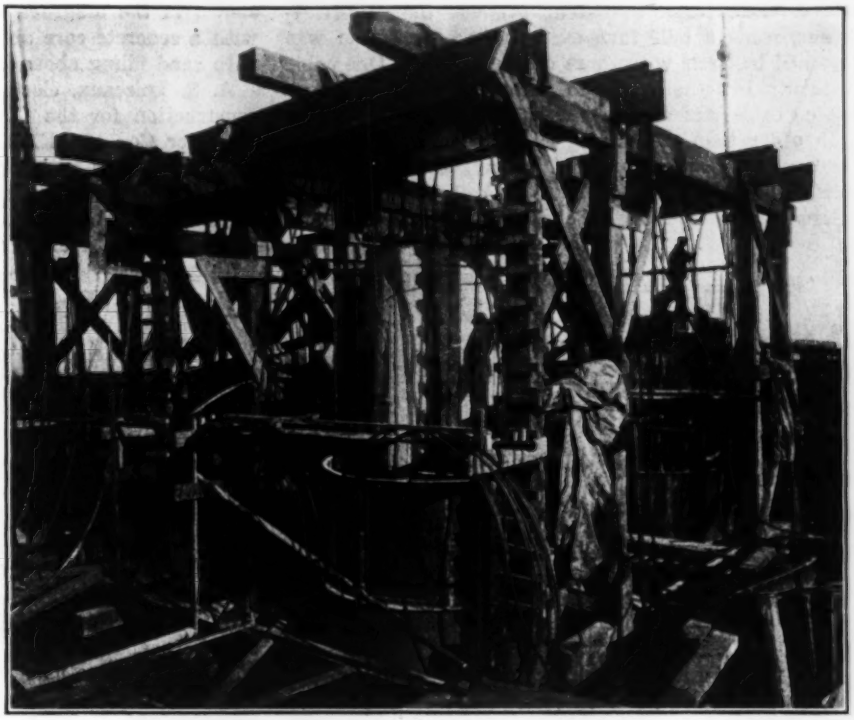
PECULIAR ground conditions in the foundations of the new hoisting tower being constructed near Baltimore for the Consolidated Power Co. forced the contractor to face the problem of sinking pneumatic caissons in such a way that allowance could be made for possible movement of the ground through which they were to be lowered. The solution finally adopted required the construction of an overhead timber frame large enough to support four caissons, one at each corner of a rectangle, from the top of which wire cables in pairs were connected with the bottom of the caissons. These



PNEUMATIC CAISSONS SUNK THROUGH SHIFTING GROUND TO SOLID BEARING

cables were then adjusted as desired during the sinking in order to keep the caissons tilted at the proper angle to allow for the effect of movement in the upper layers of earth. The caissons were sunk by their own weight until solid ground was reached, and from that point carried down about 20 ft. to hard bottom 68 ft. below water level.

The Westport station of the Consolidated Gas, Electric Light & Power Co. is located about 200 ft. from the bank of the Patapsco River, near Baltimore, Md., and the space between the power house and the river is used for the storage of coal brought up the river in barges and unloaded by a tower hoist, which is connected with the power house by a steel bridge. A 1000-ft. cableway extends from the bridge over the storage space, so that coal may either be carried directly to the bunkers in the power house or transferred to the cableway and deposited in the storage pile. The cableway is used, also, to remove coal from the storage pile when it is required to supply the power house.



FOUR PAIRS OF WIRE CABLES SUPPORT EACH CAISSON

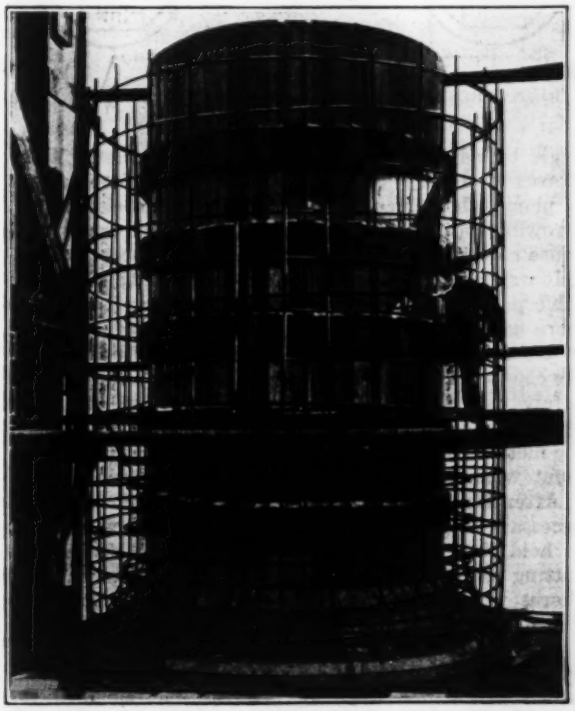
New Hoisting Tower—Last autumn the power company decided to add a second hoisting tower and a bridge, for handling coal. The company expected that it would be difficult to build a foundation for the tower, however, because the weight of the coal stored between the power house and the waterfront had started a movement of the ground toward the river which had been sufficient to throw the discharge tunnels from the power house badly out of line. Accordingly, the Foundation Co., of New York, was engaged to design and construct the necessary piers.

Borings showed that, under about 50 ft. of soft material, there was a stratum of compact sand. It was evidently necessary to sink the foundation piers far enough into this hard stratum to permit them to withstand the flow of the soft material above.

The design finally adopted consisted of four cylindrical piers, 10 ft. in diameter, centered at the corners of a 24 x 25-ft. rectangle. These piers were built with concrete walls, 18 in. thick, reinforced as indicated in one of the photographs, and were sunk by their own weight until they reached solid ground. Air was then applied, and the rest of the sinking was done by the usual pneumatic method. The piers were carried down about 20 ft. to hard bottom, making the total depth 68 ft. below water level.

Contractor's Problem—During the first stages of the operation the contractor was faced by the problem not only of keeping the caissons from sinking too rapidly, but also of holding them in alignment until they were solidly grounded. Four lines of piles were driven at right angles to the river; that is, parallel to the direction of movement of the ground. These piles were capped with 12 x 12-in. timbers and pairs of 24-in. 80-lb. I-beams laid across from one line to the next over each of the four caissons.

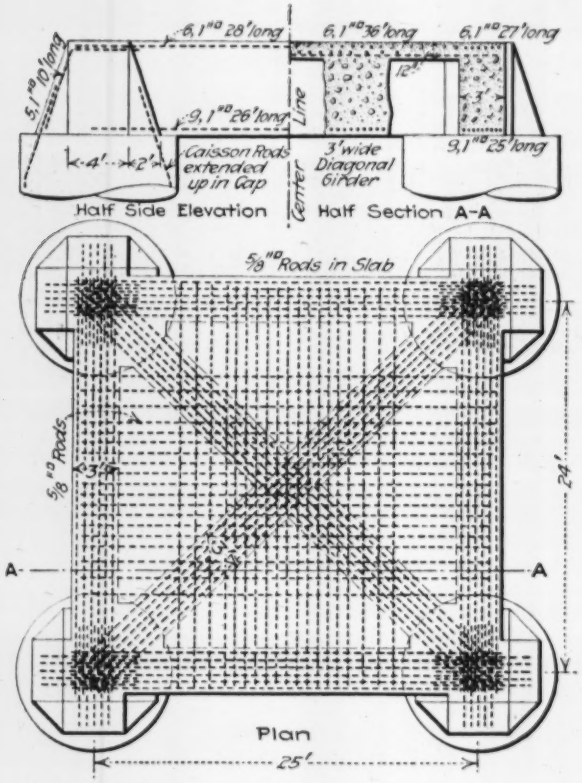
Each caisson was suspended from these I-beams by four pairs of wire cables attached to the cutting edge and extending up through the walls as they were con-



INSIDE FORMS PROVIDE KEYS FOR BONDING

creted. Each cable passed up between the pair of I-beams, made a half turn over an oak block, and was fastened to itself with three ordinary clips. One cable in each pair actually supported the load while the companion cable was held in reserve for safety.

In order that the cutting edge might be in correct position when it reached solid bottom, it was necessary to counteract the movement of the soil, by sinking the caisson out of plumb. The caisson was kept at this



REINFORCED-CONCRETE CAP FOR PIERS, BUILT OF SLAB AND BEAMS

angle by adjustment of the supporting cables. When it was necessary to throw the caissons further out of plumb, the cables on the river side were slacked off, throwing most of the load to the cables on the power-house side and causing the caisson to tilt accordingly.

It was the contractor's original intention to have each cable pass through pairs of blocks, so that it could be more easily adjusted, but as these blocks were delayed in transit, the lowering was done merely by loosening the clamps and allowing the cable to slip by itself. The safety cable in each pair was slacked off first the proper amount, and the clamps were tightened so that the motion of the caisson would be stopped at the proper point when the supporting cables were loosened.

After the caisson had been sunk 20 or 30 ft. it was necessary to shore against the side of the power house to hold it in the proper inclined position. When the cutting edge had been grounded securely, however, these shores were removed and the caisson was allowed to right itself.

After all four piers have been completed, they will be tied together at the top by deep concrete girders, which will stiffen them against the movement of the ground. Details of this cap and its reinforcement are shown in the diagram. The caissons are to be filled with a concrete core about 12 ft. thick at the bottom, with sand filling above it.

A. S. Loizeaux, electrical engineer, is in charge of construction for the Consolidated Gas, Electric Light & Power Co., and E. D. Edmonston is general superintendent of the Westport plant. The job was handled by C. B. Kowenhoven, superintendent, and William J. O'Neill, general foreman, under the direction of W. B. Taylor, district manager of the Foundation Company.

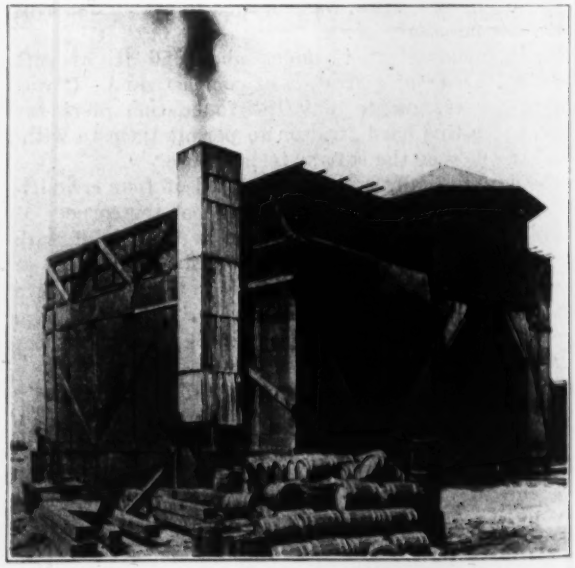
Tests to Free Under Side of Railroad Viaducts From Smoke

Special Arrangement of Ducts, Air Chambers and Fans Promises To Solve Problem of Low Headroom

BY ROBERT H. MOULTON
Chicago

EXPERIMENTS were recently conducted by the engineers of the new Union Station at Chicago to do away with the smoke nuisance created by locomotives under the viaducts. Limited headroom indicated the need for a special arrangement of ducts, air chambers and fans. A test structure was built and adjustments were made of sizes of openings, angles of baffle plates and the like, until the best combination was obtained.

Early in the designing of the station it became apparent that some artificial means would have to be employed to ventilate properly the under side of viaducts at Van Buren St., Jackson Boulevard, Adams St., Monroe St., and the structural portion of Canal St. overhanging the station tracks between Washington and Harrison Sts., a distance of ten blocks. These viaducts pass over depressed tracks and the train-shed of the station, and the use of high platforms made it obvious that smoke and gases could not be permitted to accumulate under these viaducts without seriously inconveniencing passengers and hindering operations of the station. The situation was doubly serious at the Jackson Boulevard and Adams St. viaducts, as these



TEST STRUCTURE—SMOKE ESCAPING AT LEFT

structures practically abut the concourse, and if smoke and gases were permitted to accumulate under these viaducts it would quite likely sift into the concourse and produce an extremely undesirable condition in one of the most used and important spaces in the entire station layout.

This situation prompted a thorough investigation of other stations, with a view to learning what had been done to relieve such situations. No analogous conditions were found; the situation at the Back Bay Station of the New York, New Haven & Hartford R.R., at Boston partly resembled that in Chicago, although in the main the conditions were dissimilar. At Back Bay the smoke is allowed to remain at or near the ceiling until drawn away through a number of small openings from which a system of ducts leads to ventilating fans. On account of this station having a great deal of headroom the above described method is fairly satisfactory, but it would not suffice at the Chicago Union Station, because if the smoke were handled in the restricted headroom there it would have to be dealt with on a plane only about 6 ft. above the proposed high platforms, or at about the level of a person's head.

Independent Study Solves Problem

Unable to discover anything that might lend assistance to the proper solution of the Chicago Union Station problem, the engineers began an independent and exhaustive study of their needs. After discarding as impracticable schemes which required special devices on locomotives, mechanically operated smoke ducts and one operated by the blast from the locomotives, they decided that the only device that would be entirely satisfactory would be one that could perform its functions entirely independent of the locomotive under all conditions of standing and running, and which also could be installed in a manner that would not require any structural changes in the viaduct design. A design was made of a system of open slots in the ceilings of the viaducts over the track center line. These slots were continuous in length, except where broken by the bottom flange of the viaduct girders, and were first made 30 in. wide at the bottom and 12 in. at the top, the space under the floor of the viaduct and above the ceiling being used as a gas or smoke chamber, and these chambers in turn being connected to a series of flues and ducts leading to ventilating fans.

A complete structure representing a two-track section of Jackson Boulevard was designed and erected, in order that a number of tests could be made as to the volume of smoke to be handled, the necessary air velocities and various other details, such as drainage and cleaning out soot and cinder deposits.

At the first trial of the device it was found that it worked successfully, except that when the locomotive was laboring very hard the smoke and gases had such great velocity that they would slightly overcome the suction pressure of the fan, and this caused a small amount of smoke to escape down through the smoke duct over the next track. It was not desirable to increase the power to overcome this condition, as it was found possible to do, or to construct a separate chamber for each track, on account of the expense of the extra suction flue and additional openings in the web of the viaduct girder much closer to the shearing point. Furthermore, the greater the storage capacity of these chambers the less the fan capacity. After some study

CLOSE VIEW OF ENGINE AND ARRANGEMENT OF SLOTS

of the situation a suction flue was designed with the opening continuous in the form of a slot at the top and a baffle arranged to stop the smoke and gases from passing this point, at the same time guiding them into a slot, the space below the flue being entirely closed. This arrangement operated excellently from the start, and it was not found necessary to make any radical changes throughout the rest of the experiments.

The next question was the adjustment of the angle of the baffle plates which formed the smoke duct. It was found necessary to have a width of about 30 in. at the bottom of the slot in order to catch all of the smoke from the locomotive stack. On the other hand, if the opening at the top of the baffle plates, where the smoke passed into the smoke chamber, was made too narrow, the smoke, due to its high velocity, would flare back. It was desired to make the slot opening into the smoke chamber as small as possible, as it is obvious that with a given velocity through the slot the total slot area would determine the necessary size and power required at the fan. If it were required to take care only of the gases and smoke from the locomotives while standing, or running light, a smoke slot 6 in. wide and an air velocity of 125 to 150 ft. per minute could be used. It was found, however, that to take care of all conditions, particularly an engine working hard, with the drivers slipping, it was necessary to make the smoke slot opening 9 in. and to keep the air velocity at 300 ft. per minute.

The baffle plates in the smoke ducts will be made of cast iron, as they come directly in contact with the locomotive blast. A protection plate of cast iron will be erected on the ceiling of the smoke chamber over the opening in the smoke slot.

The baffle plates will be provided with weep holes to drain the bottom surface of the smoke chamber when necessary. This undoubtedly will be seldom, as in all large experiments the smoke chambers were very dry, because of the large volume of air passing through them, absorbing all moisture and leaving a dry deposit of soot. All cinders were carried away by the fan

and were expelled into the outside atmosphere with the smoke.

While the tests have shown that the smoke chambers are very dry, it is possible that in very cold weather there may be some condensation. This, however, will be taken care of, as explained before, by weep holes in the baffle plates, allowing any moisture to drop to the floor of the track and thus be carried away by the track drains.

Viaduct Divided Into Small Units to Obtain Best Load Conditions

It was first proposed to treat each half of one viaduct as one unit of the system, but as it soon became evident that there was no economy in such a proceeding, it was decided to divide the viaducts into small units, and thus obtain the best load conditions that it is possible to put into effect at the power house.

It is intended to operate the fan motor by remote control switches at some central point, manipulated by some person from the station master's office—in all probability the same attendant that will look after the platform lights and train indicators. Automatic switches for the fan motors were considered, but were eliminated on account of their complications and their cost. The test structure was built under a contract which specified that all of the material was to become the property of the contractor when the structure was dismantled. The total amount of money that was expended on the experiment was $2500.

The engineers believe that the device is practical in every way, and they found, after a series of tests covering a period of three months, that the operation was very satisfactory and all that could be desired. This opinion was shared by outside engineers who observed the working of the device.

Safety Records in Building Construction in San Francisco

To show that safety precautions on building construction need not be costly, the California Industrial Accident Commission has compiled statistics covering work supervised by its safety engineers. An example is made of three large buildings recently completed in San Francisco, on which a particularly good record is reported. These are the California Theater and the Santa Fé and the Southern Pacific Buildings. The 10-story Southern Pacific Building, said to be the largest office structure west of Chicago, cost $1,500,000. On this job the cost of safeguarding 300 workers for a period of 12 months was $3952.50, or $13.15 for each worker employed.

On the 12-story Santa Fé Building, costing $350,000, the safety expense was $1032.35. This covered 175 workers for a period of six months, the cost per worker being $5.89. On the California Theater, which cost $500,000, thirty men were protected for 38 days for a total of $420, of which $240 was spent for nets. These were practically as good as new when the work was finished, and a salvage value of $200 is deducted from the cost of the nets, making the total cost of the safety provisions only $220. On none of these buildings was there loss of life or serious injury above the foundation level. One man was killed during the piledriving on the Southern Pacific Building.

Overhead and Time Cost to Erect Elevated Railway

Nine Hours per Ton Required to Haul, Erect, Rivet and Paint 13,500-Ton Structure—Overhead 30 Per Cent. of Total

By A. P. Roscoe
Ozone Park, New York

IT COST nine labor hours per ton and $11 per ton to haul, erect, rivet and paint 13,500 tons of steel elevated-railway structure in New York City in 1916-1918. The precise costs were 9.21 hours and $10.95. Standard methods were employed, but delays of various kinds about doubled the time which would ordinarily have been required for the work. Overhead expenses ran from 19% to 37% of the total cost of the work. Stress was laid on recording overhead, and, in particular, on itemizing the labor hours expended.

Erection operations covered 11,190 ft. of three-track elevated railway, including five stations. The route was along an unpaved street with a two-track overhead-trolley electric railway. Crossing streets were about 700 ft. apart. Traffic was light and the street was only partially built up. Obstacles to erection operations consisted principally of electric trains and trolley cars operating below the structure and of live trolley wires and feeder cables which necessitated special precautions in handling steel.

Unloading and Hauling Steel

All of the steel, 13,394 tons, and the castings, 151 tons, were delivered in the original cars to a storage yard where they were unloaded by a 15-ton steel stiff-leg derrick. Some 640 tons, made up of especially large or heavy members, were hauled to the point of erection on flat-cars and there unloaded by the erection traveler. The remainder, 12,900 tons, was hauled by a fleet of three-ton motor trucks and trailers and was unloaded onto the street by hand. The largest pieces hauled by motor truck were 15-ton 90 x 7-ft. track stringers and 26-ton 63 x 7-ft. cross-girders. The average haul was 2200 ft., and the average piece was handled three times. The hours of labor per ton unloaded and hauled were:

Item	Hours per Ton
Foreman	0.228
Hoisting engineer	0.202
Bridgeman	0.456
Laborers	0.203
Motor truck and driver	0.408
Total	1.497

The money cost of hauling and handling is of importance chiefly because it shows the proportions of overhead expenses. These are divided into general overhead and special overhead, as explained and discussed in a separate summary and discussion of overhead below. The following tabulation gives the exact figures:

Item	Loading and Unloading	Hauling	Total
Direct labor	$0.596	$0.568	$1.164
Insurance	.133	.128	.261
Meneral overhead	.246	.234	.480
Special overhead	.269	.015	.284
Total	$1.244	$0.945	$2.189

Erecting Steel—The steel erection included 211 bents, 453 columns and one express and four local stations aggregating 12,665 tons of riveted steel, 546 tons of beam steel and 87 tons of steel footing slabs. The bents

were 50 ft. apart, on an average; each consisted of two columns spaced 26 ft. apart carrying a 6-ft. cross-girder. The columns were made up of one 15-in. I-beam and two 15-in. channels with cover plates where necessary. Six 5-ft. plate girders were framed between the bents and braced laterally and for traction, to carry the three tracks.

At stations, street intersections, surface-railroad turnouts, curves, etc., this standard construction was modified to meet the conditions. Station platforms 500 ft. long consisted of two 3½-ft. plate-girder stringers supported on the cantilever ends of the cross-girders, with bracing and platform beams and a cantilever canopy. There is a mezzanine floor at each end of the station; this consists of shallow plate girders and I-beams suspended from the girders by double-angle hangers. The tracks are 13 ft. on centers except at the island express station, where they are 27 ft. 4 in. on centers.

A gantry traveler rolling on trucks on the center track stringers erected the steel. This traveler consisted of a timber platform, an 18 x 18-in. timber mast with a 16-ft. bull wheel, a 16 x 16-in. timber A-frame supporting the mast, two 14 x 16-in. timber backstays, and an 80-ft. lattice steel boom rated at 25 tons at 25-ft. radius and at 12 tons with flat boom. Hoisting was done with an 8 x 12-in. steam hoist equipped with swing gear.

The overall dimensions of the traveler were: Length 52 ft., width at front A-frame 32 ft., height from top of stringer to top of mast 47 ft. When raising steel the traveler was dogged down to the center track stringers in the rear and to one outside track stringer at each end of the front outriggers. It was hauled ahead by a set of falls attached to the cross-girder ahead and operated from the traveler winch head.

Erection of Steel

Steel was usually raised from the street surface, occasionally from motor trucks or flat-cars. The main steel was erected with the traveler falls. Cross-frames and canopy steel were erected with the boom runner line. Laterals were raised by the traveler and put in place by the fitting-up gang. At eight points the span length exceeded the reach of the boom, these spans being 80, 90, 88, 100, 85 and 90 ft. The columns and cross-girders at the 80- and 85-ft. spans were erected by the traveler boom by outhauling with a runner line reeved through a block anchored ahead of the bent being erected. The cross-girders for the longer spans were set by a steel ginpole using the traveler falls and topping lift to supply power. The heaviest piece raised by the boom was a 30-ton cross-girder.

In standard construction the average weights of pieces were as follows: Columns, two tons; cross-girders between stations, five tons; cross-girders in stations, 10 tons; track stringers, six tons; platform stringers, 3½ tons; through girders over mezzanines, 19 tons. The heaviest piece was a through girder of 91½ ft. span, weighing 36.7 tons. The longest piece was a 110-ft. platform girder weighing 12½ tons. The average panel weight was 62.9 tons and the average weight per foot of structure was 1.18 tons, or 2360 pounds.

The erection gang contained 19 men, as follows: Raising main steel, one foreman, one engineer, six bridgemen, two apprentices and one flagman; fitting up small steel, one pusher, five bridgemen and two apprentices. The hours of labor per ton of steel erected were:

Item	Hours per Ton
Foreman	0.162
Pusher	0.143
Engineer	0.158
Bridgeman	1.381
Apprentice	0.495
Team	0.091
Laborer	0.134
Total	2.564

The money cost, based on 13,300 tons, was as follows:

Item	Per Ton
Direct labor	$1.635
Insurance	.367
General overhead	.684
Special overhead	.481
Total	$3.167

Field Riveting—The total tonnage riveted was 13,211 tons, of which 546 tons were beam steel. A total of 265,800 rivets was driven by air hammers. A gasoline-driven compressor on the street supplied air to an average of 5 four-man gangs. No scaffolds were required except at column brackets. All rivets were ⅞-in. button-head, except in columns and canopies, where ¾-in. rivets were used. Labor time costs include blacksmith work, operating the compressor, laying and removing the air pipe, reaming, placing scaffolds and riveting, and in hours per ton were as follows:

Item	Hours per Ton
Foreman or pusher	0.119
Engineer	0.154
Bridgeman	2.187
Apprentice	0.245
Blacksmith	0.071
Blacksmith helper	0.041
Total	2.817

The average number of rivets driven per gang per day was 294. The cost per ton and also per 10 rivets driven was as follows:

Item	Per Ton	Per Ten Rivets
Direct labor	$1.925	$0.958
Insurance	.433	.215
General overhead	.802	.399
Special overhead	.208	.103
Totals	$3.368	$1.675

Painting—A total of 13,211 tons of steel was painted. All structural steel had received one coat of red lead before leaving the shop. After erection, all rusted or otherwise damaged portions of the shop coat were scraped and repainted. The shop coat was in good condition except for three subsections, comprising 3700 tons, which had been stored exposed to the weather for more than a year. Here the shop coat was badly damaged and required extensive renewal. The first field coat was black, the pigment being 50% red lead, 25% lampblack and 25% magnesium silicate and silica. The second field coat was olive green in color, the pigment being red lead 10%, lampblack 3%, magnesium silicate 10%, yellow ocher 67% and chrome green 10%. The vehicle for both field coats was raw linseed oil, with 5% and 6% of driers, respectively. All painting was done with flat brushes. The labor costs in hours per ton were as follows:

Coat	Hours per Ton Foreman	Hours per Ton Painters
Shop coat renewal	0.109	0.850
First field coat	0.111	0.644
Second field coat	0.078	0.540
First and second field coat	0.189	0.184
All painting	0.298	2.034

The money costs, based on 13,211 tons of steel, were

as shown in the table which is reproduced herewith:

Item	Cost per Ton: Renewal of Shop Coat	First Field Coat	Second Field Coat	All Painting
Direct labor	$0 375	$0 304	$0 250	$0 929
Insurance	071	058	047	176
Material	328	199	176	703
General overhead	151	125	102	378
Special overhead	016	014	011	041
Total	$0 941	$0 700	$0 586	$2 227

Overhead Expenses—Separation was made of overhead expenses, as shown by the tabulations, into general and special overhead. Included in general overhead are: Bond premium, interest on invested capital, lost interest on retained percentages, proportionate part of main-office salaries and expenses, field supervision, field-office rent and expenses, rent of yards, construction shanties, and legal expenses. Special overhead includes tools and supplies, plant depreciation and repairs, watchman, water boy, etc., particular to the individual operation.

The total of the general overhead items was distributed among the items of the work, first in proportion to the money value of the work and, second, in the ratio of the direct labor cost on each item. The amount charged as general overhead on any item of work was the mean of these two figures. The percentages of overhead in the various items of erection work are given by the following tabulation:

Item	Direct Labor	Labor and Material	Total
Unloading and hauling	65 5	53 6	34 8
Erecting	71 2	58 3	36 8
Riveting	52 5	42 8	30 0
Painting	45 1	23 2	18 8
Total	59 5	44 2	30 7

The cost of the steel itself f.o.b. yard is not included in "Material" in the above tabulation. If the cost of the steel is included at $40 a ton the percentage of overhead on labor insurance and material would be seven per cent.

Irrigation for Soldiers' Lands in Kansas

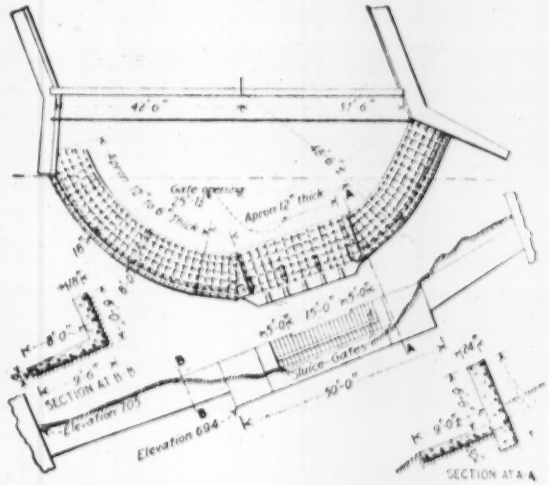
Study of the area of land irrigated and possible of irrigation in western Kansas has been made as part of an investigation concerning homes for returning soldiers. Rainfall in Kansas averages 30 to 40 in. per year in the eastern third of the state, 20 to 30 in the middle and less than 20 in. in the western third. Reports from 17 of 39 counties in the last named section showed 73,626 acres under irrigation by both ditch and pump methods, or an average of 4331 acres per county, exclusive of truck gardens. Applying this figure to the other counties and including the land which is irrigated only occasionally, the total area under irrigation is estimated at about 100,000 acres. Estimates of acreage possible of irrigation totaled 1,404,480 acres for 18 counties, or over 60,000 per county. The estimate of such land for the entire section is 1,876,080 acres. Inquiry made concerning supplemental irrigation of crops, employed only during periods when rainfall is abnormally light, showed good results from this practice.

These investigations were made by J. B. Marcellus, drainage and irrigation engineer for the division of college extension at the Kansas State Agricultural College, Manhattan.

Balanced Automatic Sluice Gate for Park Dam

In Central Spillway of Concrete Dam the Movable Timber Section Drops When Flood Height Tops Main Crest

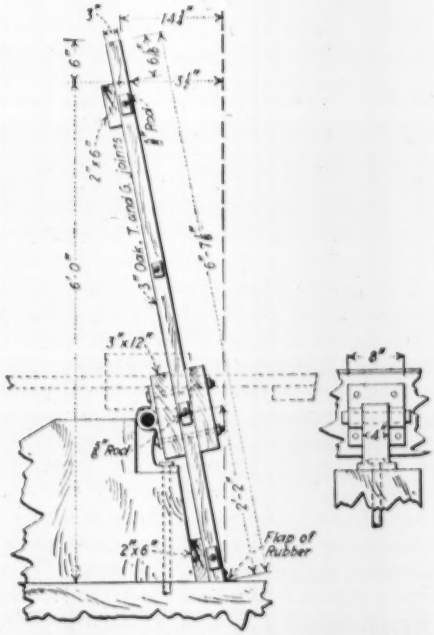
IN ORDER to provide spillway space during floods and reduce the deposition of sediment in the pool, an automatic sluice gate was designed and built for a dam in Harmon Park, Lebanon, Ohio. The dam itself is roughly semi-circular in plan, as shown in the drawing,



PARK DAM WITH MIDDLE AUTOMATIC SLUICE GATE

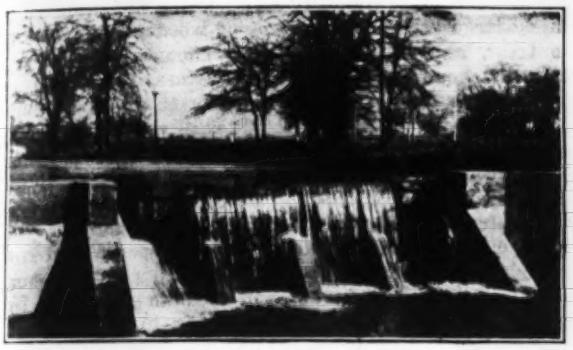
and consists of an L-shaped concrete main section with a central spillway section in which is placed the automatic wooden sluice gate.

This sluice gate, as shown in the detailed drawing, is in effect a shutter 25 ft. long and 6½ ft. deep, made



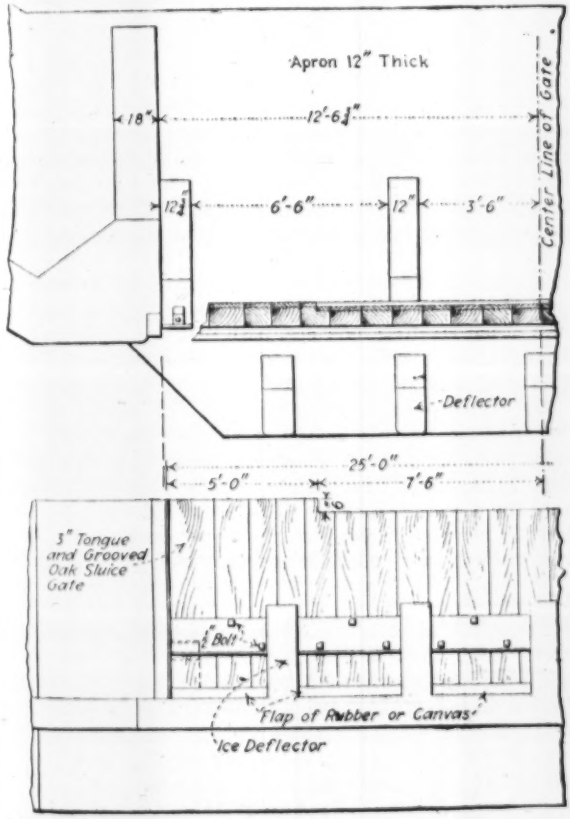
END ELEVATION OF SLUICE GATE

up of 3-in. tongue-and-groove oak plank placed vertically on a transverse 3 x 6-in. sill. This sill, which is at the lower third point of the gate, bears against hinges on concrete counterforts raised from the concrete apron



AUTOMATIC SLUICE GATE AT LEBANON, OHIO, WITH FLOOD JUST PASSING OVER ITS FULL HEIGHT

of the spillway. When the water reaches such a height that the overturning moment is greater than the resisting moment of the water head, the gate turns until it becomes horizontal and allows the flood to pass over.



ELEVATION, SOUTH HALF, LOOKING DOWNSTREAM

Small deflectors of concrete in front of the sluice gate are made of concrete walls integral with the concrete base of the apron.

The dam has now been in place about 18 months and has passed one spring freshet successfully. It was designed by Frank A. Bone & Son of Cincinnati, Ohio.

Trade-Waste Treatment Studies in Wisconsin

Wide Range of Investigations Made to Help Lessen Water Pollution—Treatment Methods—Test Plant at Milwaukee

By E. J. Tully
State Sanitary Engineer, Madison, Wis.

THE Division of Sanitary Engineering of the Wisconsin State Board of Health has devoted particular attention for some time to the prevention of water pollution by industrial wastes. Investigations have been conducted in every section of the state. The aim in selecting the system of treatment has been to combine effectiveness with simplicity of construction, reasonableness in cost and simplicity of operation, to eliminate technical supervision and to include recovery or partial recovery of waste products, as this is the ideal solution, when feasible. These investigations have included examination and small-scale experimental studies of creamery, cheese-factory, casein, canning-plant, gas-plant, brewery, tannery, rendering, glue, woolen, starch, iron and steel plant, paper and pulp mill, both sulphite and sulphate, coke-oven, chemical and dye, and explosives-plant wastes. In every instance, local sanitary requirements are the prime factors in deciding on the degree of treatment. The main purpose is to effect satisfactory reduction—depending on circumstances—in concentration of organic matter, and thereby to produce an effluent of such character that disposal by dilution may be satisfactorily accomplished, utilizing as fully as conditions permit the dilution method of purification, since it is our opinion that if a water course can receive and satisfactorily dispose of partially treated rather than completely purified wastes, without offense or detriment to riparian owners, it would be unwise and uneconomical not to take advantage of the opportunity to make the most reasonable use of the purification factors of dilution.

It has been found desirable to outline in blueprint form, after local investigation, the type of treatment unit or system believed to be adequate to accomplish the degree of purification deemed sufficient to meet local sanitary requirements. Instructions are given in constructional features and operation and care of the system. The necessity for supervision is emphasized. A wooden plank cover for the unit is specified. Considerable attention has been devoted to creamery and cheese-factory wastes, and wastes of canning factories, gas plants, tanneries and paper mills.

The procedure in the treatment of creamery and cheese-factory wastes, as these are comparable in character, includes discharge of cooling and boiler waters directly, where this is feasible; disposal of chemical wastes in excavation, and treatment of industrial waste proper, and of sewage, in case a public sewer system is not available, in a combination unit comprising two or three retention chambers. The first one contains a liming trough below the inlet or a section filled with crushed limestone, and the last is followed by a contact coke continuous chamber, and a gravel sand filtration chamber. A filtration trench is sometimes substituted for the type of filter. The disposal of casein waste is accomplished in somewhat similar manner, neutralization of the acid waste being effected by soda-ash before sedimentation, which is followed by gravel and sand

filtration. Disposal of these wastes by subsurface filtration, where the geological formation is gravel or sand, is resorted to, after preliminary treatment, when dilution is not feasible.

The canning industry is quite an important one. Wastes from this type of industry include, besides cooling waters, sewage and industrial waste proper, comprising pea and corn washings, plant washings and silage juice. Effective disposition includes direct discharge of cooling waters, discharge of domestic sewage by connection with the public sewer system, when available, conveying, after coarse screening, corn, pea, and plant washings, silage juice effluent, and sewage, when necessary, to a single point, and subjecting them to sedimentation in a three-section settling basin, and straining in a roughing filter, contact or direct, according to conditions. Preliminary treatment of silage juice is effected in a small three-section unit combining filtration through crushed limestone to accomplish partial neutralization, coke contact filtration and gravel filtration. In some instances, preliminary treatment in a single unit includes sedimentation after neutralization with soda-ash, applied from a barrel equipped with a faucet, coke contact filtration and gravel filtration. When a water course is not available or is relatively distant and a gravel formation is at hand, disposal by natural filtration in a series of excavations, after preliminary treatment, is an indicated procedure. Recovery of waste products and substances of fertilizing value is accomplished.

Tannery waste, because of its volume, usually requires large-scale treatment, the plan of disposal including differential screening in a long conduit prior to sedimentation in a two-section unit, each section comprising two chambers, and coke contact or direct filtration. Recovery of byproducts, hair and products of fertilizing value, is effected.

The plan of treating gas-plant waste consists of discharge into concrete tar-retention chambers and treatment of the effluent in a unit composed of four chambers, the first a sedimentation section containing a liming trough below the inlet, the two following chambers functioning as coke contact filters, the fourth and last a gravel-sand filter. The heavy tars recovered have been used for road work.

The relatively great volume of paper-mill wastes presents an element of difficulty in attempting to deal satisfactorily with this type of discharge. The procedure as to disposal includes the recovery of byproducts, woody suspended matter and pulp, and comprises differential screening for removal of woody suspended matters; the final screen or save-all being 80-mesh, the discharge from the screen passing into a box of adequate area containing a perforated flooring over which is laid o double layer of rope netting, which functions as a strainer or filter; sedimentation and pressing of mineral suspended material, reduction being effected before pressing by admixture with sewage, if necessary; and coke filtration, either contact or direct, or a combination of both, depending upon conditions, of "blow liquor," liquid waste proper.

Coke byproduct and chemical wastes are treated by a plan comprising chemical application, sedimentation, and aëration by discharge over shallow beds of stone, or filtration through a system comprising contact or direct coke beds, or both, and a gravel-sand bed.

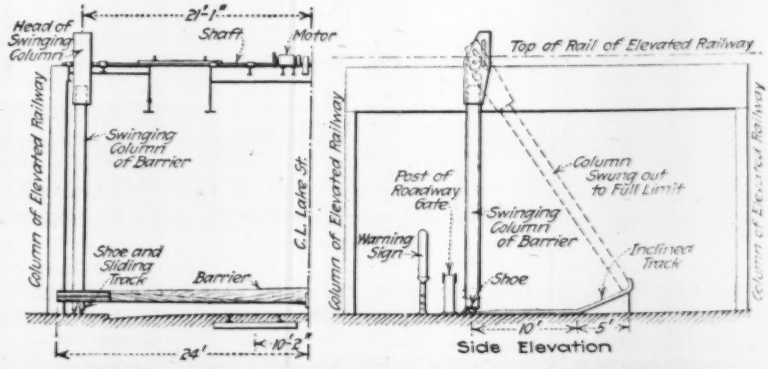
The Division of Sanitary Engineering has designed a fairly large experimental plant of wooden construction to treat, at a Milwaukee plant, chemical discharges, ammonia liquors, coke quenching waters, etc. The system comprises a sedimentation basin 15 x 4 ft. in plan and 5 ft. deep, a coke contact filter, 6 x 6 x 5 ft. deep, using 1-in. medium; a coke filter 6 x 6 x 5 ft. deep, using coke breeze as the upper layer of the filtering medium, distribution being effected by a wooden trough equipped with lateral, triangular boards, 6 in. at base and cut to a point at the end, and attached at openings of the trough; and a gravel-course sand filter, 6 x 6 ft. in plan, containing about 3 ft. of sand medium supported by coarse aggregate, with distribution as in a coke filter. The system is now in operation, and it is intended to experiment with the raw waste and to try coagulants and admixtures with sewage. A progress report will be submitted soon.

Yielding Barriers Close Roads at Drawbridges

Impact of Vehicles Absorbed by Traveling Gate to Stop Motor Trucks, and by Cables to Stop Automobiles

ESSENTIALLY different types of barriers to close the approaches to open drawbridges are represented by recent installations in Chicago and at Salem, Mass. The former, which is designed to stop the heaviest vehicles, consists of a rigid pole carried on traveling supports which move backward against sliding frictional resistance. The latter is designed only to stop automobiles, and is composed to cables attached to the pistons of oil-filled cylinders which form hydraulic brakes. Two other yielding barriers, both of the flexible or deflecting type, were described in *Engineering News-Record* of May 23, 1918, p. 1008.

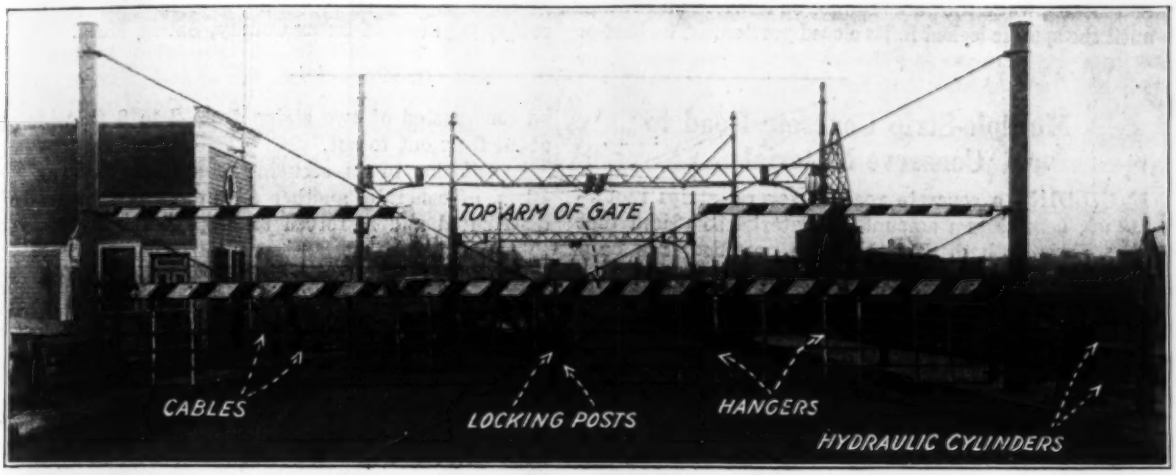
For the protection of vehicles on the approaches to the Lake St. bascule bridge in Chicago there are provided yielding barriers which are designed to stop even electric cars and heavy motor trucks that may disregard the warning signals. This is a double-deck bridge, with an elevated railway on the upper deck; when it is open the roadway on either approach ends at the edge of



RIGID BARRIER AT LAKE STREET BRIDGE, CHICAGO, SWINGS BACK AGAINST FRICTIONAL RESISTANCE WHEN STRUCK

a large open tailpit 45 ft. deep, so that it was necessary to provide some sure method of stopping vehicles approaching out of control. The barrier is placed 8 ft. beyond the usual swinging-arm gate, leaving a 20-ft. space between the barrier and the pit.

The barrier itself is a Douglas fir stick about 42 ft. long, turned to a diameter of 16 in. at the middle and having ends 10 in. square fitted to steel forks or guides. Truss rods on each side add rigidity to the timber. The forked ends engage vertical columns of 12-in. pipe which are seated on wheels and sliding shoes at the curb line and have their upper ends pivoted to a shaft carried by the girder framing of the elevated-railway approach. Each end of the barrier is attached to two ½-in. cables wound upon a drum in the structural steel head of the column, which drum also carries two similar cables for a cylindrical cast-iron counter-weight sliding inside the column. A 5-hp. motor operates the shaft and cable mechanism. The timber is housed normally beneath the girders of the elevated railway; when lowered, its center line is about 2 ft. above the roadway.



FLEXIBLE BARRIER OF CABLES YIELDS UNDER IMPACT BY PULLING OUT PISTONS IN HYDRAULIC CYLINDERS

While the column has a rotating motion around the shaft it is not journaled to it, the shaft lying in a slot which permits vertical movement of the column. The foot of the column has a 10-in. wheel resting on track rails parallel with the curb, and outside of the wheel are shoes sliding on flat track plates so as to afford frictional resistance. The rails and the track plates are inclined, as shown in the drawing. When the barrier is struck the columns roll back on the wheels until the shoes engage the track plates and slide upon them. The steep incline of the end portions of these adds further resistance, and an end stop limits the total travel to 15 ft., with a vertical rise of about 2 ft. in that distance.

As a test, an old eight-ton electric car with front end reinforced against the shock was run against the barrier at a speed of 12 miles per hour, carrying the barrier to the full limit of its travel without injury to the barrier or the car. No unintentional test due to careless driving has occurred. To provide against street cars being held on the bridge by the lowering of the barriers, there is an automatic interlocking device which prevents operation of the barriers or the bridge while a car is between the gates.

This yielding barrier was designed by F. H. Avery, engineer of bridge construction and repairs, Department of Public Works, Chicago, who superintended the plans and construction under the direction of John Ericson, city engineer, and Thomas G. Pihlfeldt, engineer of bridges. The contractor was S. P. Harding.

Protection of automobiles on the approaches to the Essex drawbridge between Salem and Beverly, Mass., is afforded by flexible yielding barriers which are designed to stop light vehicles and which it is thought will check heavy trucks to such an extent that they can be stopped in the 75-ft. distance between the barrier and the draw opening. While a street car or heavy motor truck at high speed would probably break through the barriers, it was considered best not to attempt to make them strong enough to stop a truck, while the stopping of street cars was considered to be a matter for the electric-railway company.

Each barrier is composed of two horizontally swinging gates or leaves which meet at the center of the roadway. Each leaf consists of a combined steel and wood arm placed 5 ft. above the roadway and carrying hangers through which are led four ⅜-in. wire cables 10 in. apart. At the outer end of each leaf the cables are attached to a vertical member hung from the top arm but free to disengage from it. When the gates are closed the locking mechanism on these members is engaged by levers, so that the cables form a continuous structure across the roadway.

At the hinged end of the leaf each pair of cables is looped around a stirrup to which is attached a ¾-in. cable passing over a horizontal guide sheave on the gate post and attached to the rod of a piston in an oil-filled cylinder. The two cylinders on each side are mounted in a frame placed parallel with the curb. Should the gate be struck by a vehicle it will yield, the pressure on the gate cables pulling out the four pistons against the resistance of the oil. The top arms are hinged at two points in each leaf and are not connected at the center, so that they are free to follow the curve of the cables without breaking. At the same time the hinges are so supported as to prevent vertical deflection of the arm.

Wrought-iron pipe of 5½-in. inside diameter is used for the cylinders, with a piston diameter $\frac{1}{16}$ in. less. Through the $\frac{1}{32}$-in. annular space the oil escapes as the piston is pulled forward. To prevent excessive pres-

sures and a too sudden stop to a light vehicle moving rapidly, a safety valve provides for escape of a portion of the oil when the pressure reaches 8000 lb., or about 500 lb. per square inch. The oil used is that employed in refrigerating machinery, which thickens only slightly even at a temperature of several degrees below zero. Under average conditions the resistance afforded by each cylinder is about 4000 lb. against a piston moving at the rate of 3 ft. per second. This means a total resistance of 16,000 lb. for the four cylinders of each gate. The gate posts are designed to withstand the reaction of the cylinders together with a downward pull on the gate arm. A travel of 4 ft. by the pistons allows for a 12-ft. deflection of the 42-ft. gate.

Interlocking the gate locks with the bridge-lock lever prevents operating the bridge until the gates are closed and locked, while the gates cannot be released and swung until the span is locked in its closed portion. The bridge locks are released by hand levers and the gates are swung by hand, being in charge of a bridge watchman. The 3 x 9-in. timber on the top arm of the gate is painted in diagonal stripes of black and white, and the gate is made still more conspicuous by a similarly painted plank carried above it by the gate post and a guy rod. On the top arm of each leaf is a lamp showing red toward the roadway and throwing a white light on each side to illuminate the painted arm. Warning signals are to be installed 300 ft. from the bridge.

No test, either intentional or accidental, has been made by moving vehicles. This bridge is opened only at long intervals, but is on a main highway which averages a traffic of over 3000 vehicles per day in summer, mainly automobiles. As the road is straight, most of these vehicles travel at considerable speed. The flexible yielding barrier was designed by Robert R. Evans, county engineer of Essex County, Salem, Mass.

Multiple-Strip Concrete Road to Conserve Material

BUILDING a concrete road in several strips requiring a minimum amount of material so placed that wheel-ways in both directions are provided, has been resorted to on a roadway leading tc Lewis Point, St. Augustine, Fla. Duval County has since let a short stretch, and various other counties of Florida will advertise, in the near future, for a considerable mileage of this type of construction.

On the Lewis Point section, a view of which is shown, the specifications called for three strips 6 in. thick and with dimensions and arrangement as shown in the diagram. The concrete specifications call for Columbia granite in sizes from ½ to 1½ in. Lake Weir sand, which is considered one of the best sands in the state, was used. The proportions were 1 : 2 : 4. The slab was laid in one course, with ½-in. transverse-expansion joints

CROSS-SECTION OF MULTIPLE STRIP ROADWAY

every 15 ft. The concrete was thoroughly tamped and was finished by the canvas-belt method. All edges were rounded with a ½-in.-radius edging tool to obviate chipping under traffic.

The outside forms were set first in the usual way, the interior forms being left until the work was started, when they were placed in short lengths so as not to interfere with the concrete mixer. Setting the interior forms was accomplished very expeditiously by resting a templet cut to the proper crown upon the outside forms. They were set to line by means of the templet and spacers. The forms were of wood and were doweled together at the ends. When the forms are removed the space between the strips of concrete can be filled with gravel, crushed stone or other suitable material.

In normal times this road can be built in Florida for $2.50 per square yard of concrete. A contract for 850 sq.yd. was recently let by Duval County at the rate of $2.82. This would naturally be reduced on a larger contract. Where only single-track road is required it may be constructed of two strips from 2 to 3 ft. wide and about 8 ft. out to out.

In addition to the securing of a 15-ft. roadway with 10 ft. of concrete, another advantage is that traffic is distributed and is forced to keep to the right. It is

COMPLETED MULTIPLE-STRIP DOUBLE-TRACK ROADWAY

thought that this distribution will tend to reduce accidents and increase the life of the pavement.

The work shown was laid under the supervision of E. M. Wellman, construction engineer, of St. Augustine, and the plans and specifications were prepared by S. N. Cornwall of the National Highway Corporation, Jacksonville, Fla., who holds a patent on this type of road.

Tests of Wrapped Airplane Struts

Compression tests of wrapped and cloth-covered airplane struts made of cross-grained Sitka spruce and Douglas fir, in comparison with struts not covered, have shown that the wrapping and covering are of very little value. The Forest Products Laboratory, which carried out the tests, states that wrapping with cotton tape had no appreciable effect on strength. Governing with Bakelized canvas increased the buckling load and the deflection at time of failure; in other words, it increased both the strength and the resilience or shock-resisting capacity of the strut. However, the strength per unit of weight was decreased. The conclusion reached is that all the coverings tested have less value than the same volume of wood.

Precast Plates Form Shell of Concrete Barge

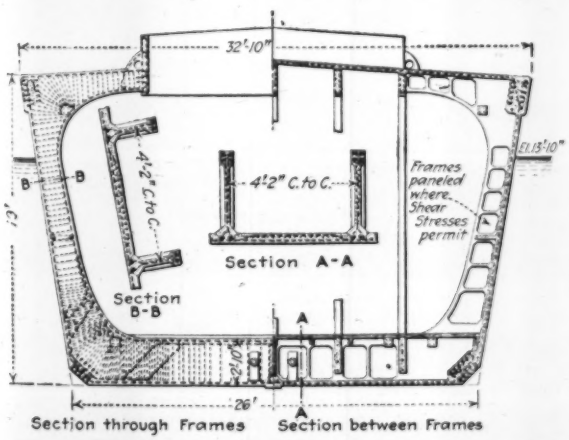
Bottom and Sides of Experimental Boat Built in British Yard Are Tied Into Frames Poured Inside of Forms

CONCRETE barges being built in a new yard in England have sides and bottoms made up of precast concrete plates fitting between the frames, which are cast in place according to the usual methods in concrete-barge construction in this country. An article by W. N. Twelvetrees in a recent issue of London *Engineering* describes the yard and the method of construction, devised by Capt. J. H. Waller, now with the British Army, but recently a civil engineer in Dublin.

The first barge built was in general accordance with the plans and specifications of the British Department of Merchant Shipbuilding. It measures 187½ ft. in length overall, 32 ft. 10 in. breadth at deck level, and 19 ft. in depth. The cross-section herewith shows the general type of design. The frames, continuous across the boat, are reinforced as shown. Longitudinal stability is insured by gunwale and bilge girders and a center keelson. All of these are poured in place at the same time as are the frames.

The bottom of the barge is formed of two rows of plates 3 in. thick, each plate being 11 ft. long by 2½ ft. wide, the end joints occurring at the bilges and center keelson, and the side joints are successive transverse frames—that is, every 4 ft. 2 in. The sides are formed of plates about 15½ ft. long by 3½ ft. wide and 3 in. thick, the end joints being at the gunwales and bilges and the side joints at successive transverse frames. The deck plates are only 2 in. thick and are jointed at the gunwales and hatch coamings. All the joints are in planes at right angles to the longitudinal axis of the vessel, and the edges of the plates are chamfered so as to permit the additional bond of the poured joint concrete. Rods project from the precast plates along all sides, and are bent perpendicular to the plates and twined around the bars inside the frame forms.

The plates are cast in a special yard connected by industrial track to the shipways, and are handled to the ways by derrick cars. In construction, the first work is to place the bottom plates on timbers laid across the shipways. These form the bottom of the ship, and the forms for the bottom and side frames are erected between and alongside of the bottom plates. After the side forms are up, the side plates are slipped in place, with the steel protruding and the frames poured. The deck plates are then erected, and the deck forms for the poured concrete are put in place, after which the boat is finished up.

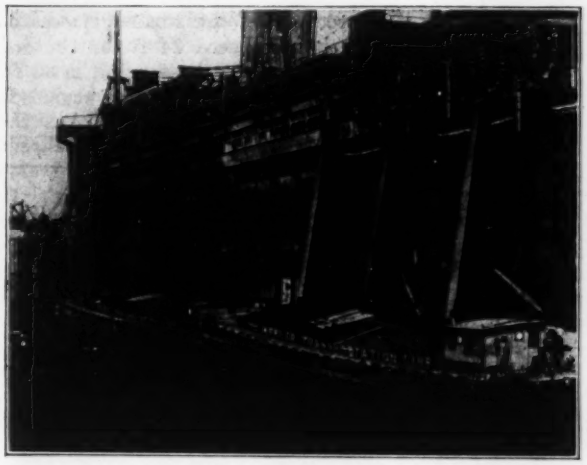


CROSS-SECTION OF BRITISH CONCRETE BARGE WITH SHELL OF PRECAST PLATES

Bucket Chain Conveyors Coal Transports

RAPID turn-around of the United States transports is being materially helped by the use of a mechanical coaling system which speeds up the filling of the coal bunkers. This apparatus has been used regularly at the Army transport bases at Hoboken, N. J., and Newport News, Va. While exact figures are not available, it is stated that the time in port has been reduced at both terminals.

The device consists of an endless-chain inclosed bucket elevator which is suspended by tackle from the side of the ship and which discharges into side ports of the vessel.



COALING THE "LEVIATHAN" WITH MECHANICAL CONVEYORS DISCHARGING INTO SIDE PORTS

When not in use the units are disposed on the adjacent pier. The elevator consists of two main members: The head, in which is installed an electric driving motor, and the leg, which slants vertically to the head and is raised and lowered as desired. The coal conveyor, of the endless-chain and bucket type, engages the coal at the boot of the leg.

When all is ready for operation the leg is raised sufficiently to allow the barge to move under it and is then lowered into the coal. The buckets lift the coal up only to the head and not to the top of the conveyor, and there permit the coal to be discharged into chutes which can be turned so that the slope will carry the coal into side ports. The view herewith shows the machine in operation on the U. S. A. transport "Leviathan" at Hoboken. The elevator is controlled by the Michener Stowage Co., New York City.

Heavy Shop Framing for 250-Ton Traveling Crane

Columns Carry Double-Deck Runways With T-Section Girders for Overhead Crane Handling Locomotives — Wood Paving

SPECIALLY heavy structural steel work is required in the repair shop now being built for the Pennsylvania Lines at Logansport, Ind., in order to carry what is believed to be the largest and most powerful electric traveling crane yet built for handling locomotives. Plate girders 5 ft. deep with 22-in. stiffening chords are supported on the H-section flanges of columns 48 in. wide. The crane has a lifting capacity of 250 tons and a span of nearly 86 ft. between the runway rails. It will pick up the heaviest locomotive and carry it over other engines to any one of the repair tracks. In addition, there are 10-ton traveling cranes of nearly 83-ft. span, which operate on runway girders below those of the larger crane.

The repair shop is 420 x 195 ft. and has its width divided into three bays: A 90-ft. erecting shop with 54 ft. clear height, a 73-ft. heavy machine shop 34 ft. high, and a 30-ft. light machine shop with a mezzanine floor for tool room, toilet rooms and the smaller classes of machines. The columns are spaced 24 ft. on centers, except that in the two end panels the spacing is 30 ft. Trusses carry the roofs of the two larger bays. In the 75-ft. bay each third panel of the roof has the purlins carried by the bottom instead of the top chords of the trusses, thus forming a series of transverse monitors which provide for light and ventilation. In the 30-ft. bay the roof is carried by I-beams. The upper floor in this bay has steel framing incased in concrete and covered with a concrete slab on which is laid wood-block paving. This floor is designed for 300-lb. live load and 100-lb. dead load.

A T-section is used for the columns of the erecting shop. It consists of a 48-in. web plate with flange angles, and a heavy inner flange composed of one 18-in. I-beam and two 15-in. channels, as represented in Fig. 3. This flange carries the runway for the 250-ton crane, while the rest of the column section, narrowing to 24-in. width, extends up to carry the roof trusses. Separate columns are provided for the runway girders of the 10-ton cranes; these are 12-in. I-beams, placed just inside the main columns and tied to the latter by diaphragms. These posts rest on the same bedplates and footings as the main columns, but have separate shoes and anchor bolts.

The runway girders for the 250-ton crane are 60 in. deep, and are of the section sketched in Fig. 3. (See next page). The top flange is a horizontal girder composed of a 22-in. plate with four flange angles, the 150-lb. crane rail being laid on this web plate and secured by horizontal bolts which pass through the web of the rail and the upper flange angles on the plate. The flange is capable of taking a side thrust equal to 10% of the lifting capacity of the crane. In the design of the girders 25% was added to the live road to allow for impact. The wide top chord provides resistance for

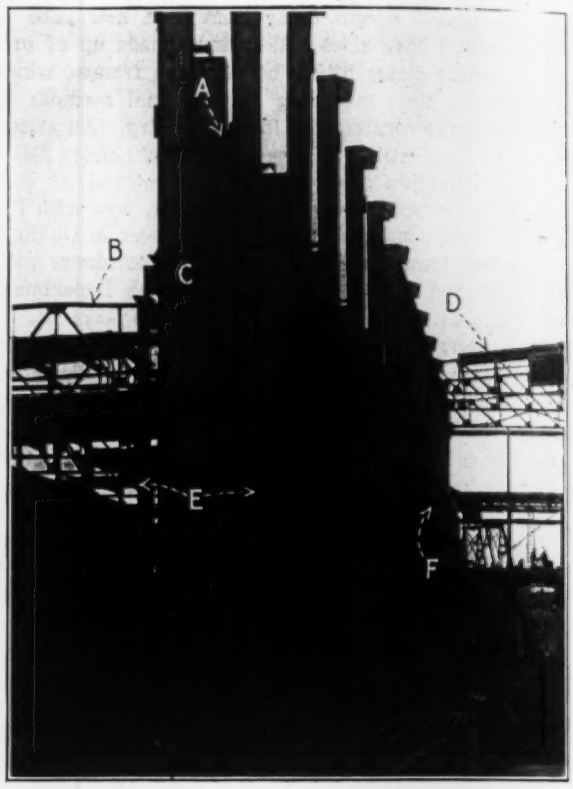


FIG. 1. HEAVY COLUMNS FOR 250-TON 86-FOOT CRANE IN RAILROAD REPAIR SHOP

A. Seat for runway girder of 250-ton crane. B. 75-foot machine shop. C. 48-inch main column. D. 90-foot erecting shop. E. Columns for runways of 10-ton cranes. F. Longitudinal strut

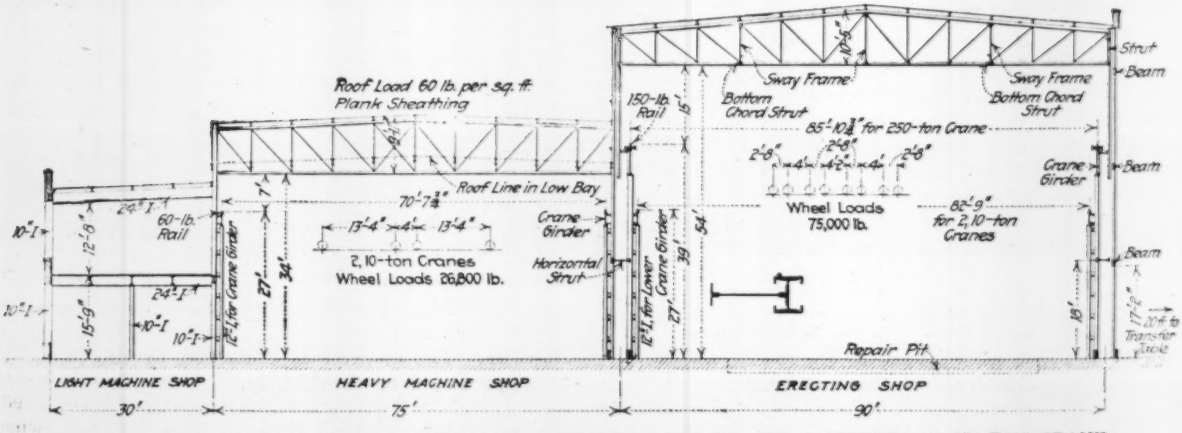


FIG. 2. CROSS-SECTION OF LOCOMOTIVE SHOP, SHOWING WHEEL ARRANGEMENT OF 250-TON CRANE

a side thrust equal to 10% of the lifting capacity.

In the case of the 28-in. I-beam runways for the 10-ton cranes, lateral stiffening was provided by riveting a horizontal 10-in. channel to the upper part of the web; this channel bears against the face of the column. The

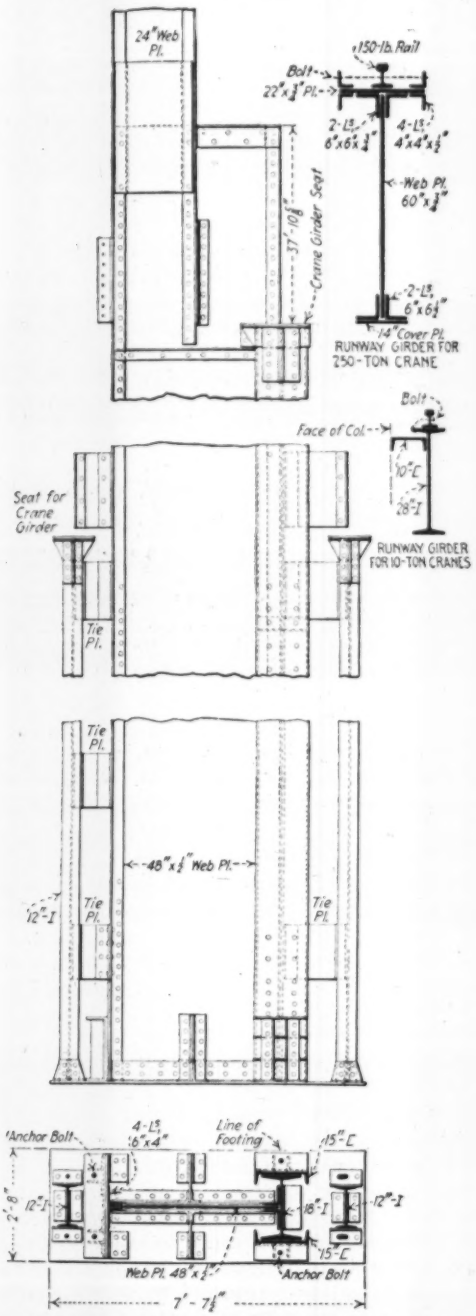


FIG. 3. CRANE COLUMNS AND GIRDERS

60-lb. crane rail is secured at 48-in. intervals by bent hook-bolts, alternating on opposite sides of the rail, engaging the edge of the I-beam flange.

Concrete sills are used in the brick walls, being found considerably cheaper than the stone ordinarily used. Wood-block paving 3½ in. thick, laid with tar cushion on a concrete base, covers the entire area of the first floor, except that the concrete walls of the pits in the erecting shop are capped with 5 x 9-in. oak timbers to form supports for the jacks used in raising or blocking up the engines.

For lifting locomotives the large crane has two hoisting trolleys, each of 125 tons capacity, which are normally spaced about 45 ft. on centers and pick up the engine by both ends. Each trolley has also a 10-ton auxiliary hoist. Magnetic control is employed throughout, with dynamic control on each hoist. The crane has each end of its bridge carried by a group of eight wheels mounted in double compensating trucks and equipped with an electric motor, so that each group of wheels is driven independently.

Across the floor of the erecting shop are 17 parallel transverse stub tracks, three of which extend into the machine shop and each of which has a 56-ft. repair pit. These tracks are spaced 24 ft. on centers and are at right angles to the crane runways. They extend 20 ft. outside the building to the pit of a 60-ft. transfer table of 250-ton carrying capacity, and having a 75-hp. electric motor which operates it at a high speed of 100 ft. per minute when carrying an engine. This table has a travel of 540 ft., running beyond the ends of the building so as to connect with yard tracks on which engines are moved to and from the transfer table.

This new shop was built by the Austin Co., Cleveland, Ohio, which also made the plans for it, subject to the requirements of the engineering and mechanical departments of the railway. J. E. Anderson was the company's superintendent of construction. All work is under the direction of Robert Trimble, chief engineer of construction, Pennsylvania Lines. W. E. Guignon is division engineer at Logansport, with T. L. Doyle as assistant division engineer.

Some Engineering Problems of Regional Planning

By Morris Knowles

Chief Engineer, Housing Department, Emergency Fleet Corporation, United States Shipping Board

Abstract of paper read before the National Conference on City Planning, held two weeks ago at Niagara Falls and Buffalo—Solution requires comprehensive planning of all features with consideration of their relation to one another, for greatest good at lowest cost.

TOWN planning as a conscious art had its birth in the desire to add beauty and attractiveness to towns for which, it was at first assumed, the problems of convenience, sanitation and amenity had already been reasonably well solved. Therefore many town planners, enthusiastic in their quest for "the city beautiful," lost sight at times of the engineering problems of town planning. But all this is changed now, for experience has proved the interdependence, in city building, of beauty, convenience, sanitation, amenity and economy. And so, from being a question of art, town planning has become more and more one of engineering.

Regional planning is still newer as a conscious art. Born from the efforts of neighboring towns to coöperate in the solution of their joint engineering and utility problems, it has developed until today its ideals, as applied to regions, are as broad as are those of town planning.

The origin of this new art guarantees from the start that its dependence upon engineering will be recognized. Beauty is as vitally necessary in regions as in towns;

but, as the region is a little more remote from the individual than is the town, it is easier to see that the prerequisites of beauty are sanitation, convenience, amenity and economy, and that many of the most important problems of regional planning are engineering problems.

Among the problems to be studied are those associated with the geographical and industrial characteristics of the region; the development and interconnection of steam, electric and water transportation; the arrangement and construction of main highways; joint water and sewerage systems; the regulation of streams; the supply and distribution of light and power; the organization of regional utilities, and the apportionment of the cost of regional works.

Survey—The first requisite of a regional plan is a comprehensive survey of the topography, geography, population, natural resources, agriculture, industry and trade of the region, much of which is an engineering study. And one result of such study should be a complete topographic map of the area, which may serve as a base map for the regional plan. Not only should this map show the topography, and locations of the towns, railroads, streams, canals and other natural and structural features, but the data on natural resources, agriculture and industry should be correlated with the map in such manner that maps may be prepared showing the relative distribution of all the factors affecting the life of the region.

Steam and Electric Transportation—Steam railroads are the arteries through which the life-blood of our country's trade flows. Regional planning must take into account the fact that steam railroads are best adapted for long-haul, through traffic. It must, of course, be based upon the existing railroad systems, and must provide yards and terminal facilities, both for facilitating through movement and for transfer to local, short-haul roads and to electric and water transportation routes. The study of electrification must be continued in connection with the elimination of noise and dirt from our cities, and with the general power program for the region in which the railroad is located. And a new type of organization and regulation must be found which will at the same time protect the public interest and encourage growth sufficiently to serve the needs of industry. The electric roads are the natural complements of the steam railroads.

Regional planning will recognize more clearly than ever before the necessity for interconnecting the various types of transportation routes, for building joint terminals, with adequate wharves, docks, warehouses, railroad yards, cranes and electric facilities, so that the transfer and transshipment of passengers and freight may be accomplished most economically and most efficiently, and so as to secure the greatest usefulness from the transportation system as a whole.

Main Highways—If the railroads are the arteries of trade, then the highways are the vessels through which the individuals engaged in commerce receive the blood which quickens their lives. But regional planning cannot permit the location and construction of the highways of the future as have been many of those of the past. Main roads will no longer be located with reference to section or property lines, but with reference to topography, the distribution of products creating traffic streams, and the coördination of the highway system with the railroads, electric lines and waterways; and types of construction will be carefully adapted to traffic needs—not only as to road widths, but also as to gradients, surfacing and drainage.

The regional plan, therefore, should provide a program harmonious with the programs for the solutions of the other problems of the region, which may serve as a guide for the construction of main highways during years to come.

Water and Sewerage Systems—The advantages of regional water and sewerage systems are often particularly striking, and serve excellently to illustrate the value of the regional plan. Water-supply problems depend for their solution more upon the source of supply than upon any other consideration. Sewerage is strictly a drainage-area problem, and unnecessary expense as well as mutual damages of many kinds result from attempts to solve it with respect to political boundaries alone.

Stream Regulation—Another problem for which satisfactory local solutions are obviously impossible and drainage-area solutions absolutely indispensable is that of stream regulation and water conservation. Navigation requires a uniform, sufficient depth of water throughout the navigable length of the stream. Local flood-protection works may actually increase flood heights above or below them. The interdependence of the water and sewerage problems of communities within a region has already been pointed out. The best utilization of water-power requires that its development and distribution be based on regional, and not on local, considerations. It is of great importance that stream regulation be based upon the consideration of all the uses of water, and not on one of the above.

Light and Power—The type and the locations of regional sources of light and power will depend largely upon the characteristics of the region with respect to availability and location of coal, natural gas and hydroelectric power. But the economic advantages of power generation in large central station need no demonstration in these days of efficient, large-capacity generators and of high-tension transmission. Enlightened self-interest has long recognized this, and the results may be seen in the unification of the gas-supply systems in the neighborhood of every field of natural gas, and in the huge electric central stations and the network of electric-supply and distribution lines which characterize every one of our large urban districts.

Organization—Organization for carrying out the works of a regional plan is not solely an engineering problem. Existing political organizations must, of course, be the basis of it, and intricate legal and organization problems must be solved to build up the group of related organizations (for each problem may require separate organization), required to secure the results desired. But the selection of desirable types of organization is so closely tied up with the planning and use of the public works involved in a regional plan that no consideration of its engineering problems would be complete without reference to it.

The type of organization depends in each case not only upon the existing political organization and upon the area and density of population of the region, but also upon the particular purpose or combination of purposes to be accomplished. Dependent upon these factors, examples of community coöperation can be found,

varying through a wide range with respect to the functions involved, the degree of centralization of control, and the methods used in financing and apportioning cost.

Most of the important cases, however, can be classified under one or another of six heads, as follows: (1) Extension of municipal limits, and consolidation or annexation; (2) extension of municipal jurisdiction; (3) contracts between municipalities; (4) county administration; (5) private enterprise and (6) district organization.

Within a given region, each of these types of organization may be represented. But the conception of regional planning contemplates the direction and guidance of all of them by the regional plan—that the plan shall be a kind of regional constitution with which the subsidiary organizations of the same region must not conflict.

Apportionment of Cost—Like the problem of organization, apportionment of cost is in large degree a financial, legal and political problem, but, like the selection of organization types also, it is so closely bound up with the use of public works that it is largely an engineering problem, too. In most cases, the method used may be classified under one of four headings, or as a combination of more than one of them, as follows: (1) General taxation; (2) regional general taxation; (3) special assessment, and (4) rates based upon quantity of service used.

Conclusion—The great engineering problem of regional planning is the comprehensive planning of all of the features with consideration of their relation to one another, so as to secure the greatest good at the lowest possible cost. Steam transportation must not be developed without references to or in unnecessary competition with electric and water transportation. Main highways must not be planned solely with a view to carrying through traffic—if, for example, a slight modification of the location of a boulevard would provide a right-of-way for a trunk sewer and avoid the condemnation of expensive additional property, it would be indefensible to fail to consider it. Sewage outlets must not be located without reference to water intakes. Stream regulation must not be studied for one purpose, but consideration must be given to water transportation, flood prevention, water-supply, sewage dilution and power development, so as to secure that combination of results which represents the greatest good per dollar spent for the entire region.

If this broad engineering conception of regional planning can be kept before us, all of the inherent advantages can be realized and its future will hold for mankind a store of benefits as much greater than those which have come from town planning as its field is more extended.

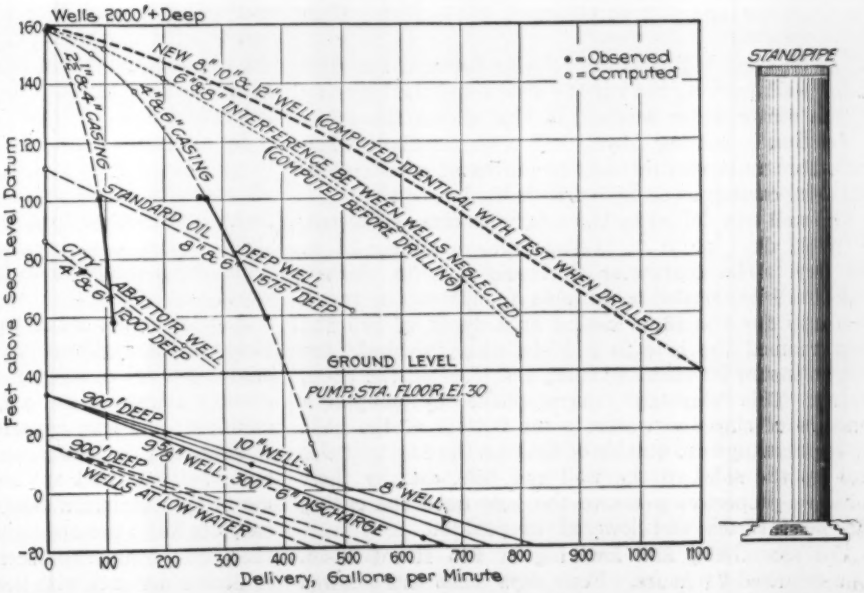
Artesian Well Experience at Baton Rouge, Louisiana

Larger Well Casing Gives Increased Flow — Temperature a Factor in Yield — Well Sunk About 2000 Feet in 62 Days

FOURTEEN artesian water-bearing strata 5 to 194 ft. in thickness, all of which are separated by thick layers of tough blue clay, underlie the City of Baton Rouge, La. A report by Alvord & Burdick, following exhaustive exploration tests to various depths for the Baton Rouge Water Co., indicated that at the 2000-ft. level a suitable soft water under high head would be obtained. L. R. Howson, of the firm, described certain features of the unusual ground water-supply conditions, at a recent meeting of the Illinois Section of the American Water-Works Association. Salient points in his paper are given in the following abstract:

As no rock is encountered and the holes must be cased the entire depth through the many strata, some of which cave badly into the larger holes, it was thought that the largest casing that could be successfully lowered into place, on account of the great length to be supported, would be 8 in. for the top 1300 ft. and 6 in. for the remainder of the depth. It was estimated that such a well would yield 840 gal. per minute free flow at the ground surface, since the static head is 120 ft. above the ground level. When the well was sunk, however, the contractor, W. M. Eberhart, was persuaded by the water company, despite the fact that he was not to be paid according to yield, to attempt a larger casing than had been used heretofore in the vicinity. Accordingly, he placed 915 ft. of 12-in., 934 ft. of 10-in., 44 ft. of 8-in. casing, and a 70-ft. strainer consisting of perforated well casing wound with brass gauze.

A flow of 1100 gal. per minute at the ground surface was secured, the increase over that expected with the 8- and 6-in. sizes originally proposed being due to the smaller friction losses in the larger casing. When the



RELATION BETWEEN YIELD OF WELLS AND LOWERING OF STATIC WATER LEVELS

large well is delivering at the 1100 gal. per minute rate approximately 50% of the total head loss is due to actual lowering of the water level, and the remainder to frictional resistance in the well casing. With the 6- and 4-in. well flowing at the ground surface the total head lost is consumed in the ratio of 25% for the draw-down and 75% for friction, the large pipes giving more than double the amount of water under similar conditions. At 2050 ft. a 60-ft. sand layer was penetrated, which produced a well having specific capacities, or yield for each foot the static level is lowered, of from 12 to 15 gal. per minute and a temperature of 92° F. The static water level is 160 ft. above sea level, or 120 ft. above the ground surface.

Tests on existing wells of the company gave the following data: From wells 200 to 400 ft. deep the static elevation of the water is near sea level, and the temperature is 64° F. Baton Rouge is 40 ft. above sea level. Wells 800 to 900 ft. deep penetrate a 50-ft. sand layer, yielding 10 to 12 gal. per minute per foot of draw-down from 6- to 12-in. walls. The temperature is 72°, and the static level is 35 ft. above sea level. From a sand layer at the 1320 to 1350-ft. depth a water of 85° temperature rises 110 ft. above sea level, but the specific capacity is only from 1 to 2 from a well of the water company and 6½ from a city well recently drilled.

The various gravel and clay strata under Baton Rouge dip to the south 20 ft. to the mile, so that a porous stratum outcropping near Jackson, Miss., is penetrated at Baton Rouge, 125 miles to the south, at 2050 ft. below sea level. Over an area of 20,000 square miles just south of the Louisiana-Mississippi line the surface becomes rolling and rises rapidly to from 200 to 400 ft. above sea level. Above 100 ft. it is gravelly and presents an excellent collector.

The gravel strata are separated by light, impervious material which prevents interconnection and accounts for the variation in static pressures. The variation in temperature is important because well yields depend upon the rate of flow through the sand, and water at the 92° of the 2000-ft. depth passes through sand, of the character and size encountered, 175% faster than would water at 50 degrees.

The diagram indicates the relation between the yield of the wells tapping the various strata and the lowering of the static water levels. It also shows the effect of friction in cutting down yield very materially when the water must rise through two-fifths of a mile of 4- and 6-in. casing, as compared with the larger sizes.

The well was drilled by the rotary process and tested, all in 62 days, or at an average rate of nearly 34 ft. per day. The contractor first ran a 10-in. fishtail drill until he located a suitable foundation in tough blue clay for the 12-in. casing at a depth of 915 ft.; then reamed the hole to a 16-in. size, "slushed" the hole to insure its standing open, and inserted the 12-in. casing. This "slushing" is accomplished by pumping a mixture of clay and water to the bottom of the hole. As it passes upward outside of the pipe the clay particles seal up the sides of the well and hole, and by their cohesive properties preserve the hole until the casing can be inserted and lowered to position.

The assembling and lowering of 915 ft. of 12-in. pipe required 7½ hours. Four days' time was allowed for the sand to set around this casing before drilling for the 10-in. casing was started. Similar methods were followed for the 10-in. and 8-in. casing and the 70-ft. strainer.

A large number of wells have been drilled in and near Baton Rouge in addition to that of the water company, the most important being the group of 14 wells drilled by the Standard Oil Co. to supply cooling and condensing water for its oil refinery. These wells furnish nearly 5,000,000 gal. per day. This water is, of course, air-cooled, but all the city water must be iced before using.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

More English, Not Greek and Latin

Sir—Anent the discussion of Latin and Greek for engineers, I wonder that it has never occurred to the people who criticise the engineer for his narrowness of training and outlook that there are others. An experience of a good many years of association with educated people in other lines leads me to the conclusion that the engineer is not peculiar in having a somewhat narrow outlook and that, indeed, he is less of an offender, if this be an offence, then a good many other persons presumed to be of at least equal training. True it is that the engineer is more familiar with the doing of things than with the telling about things. True it is that he has what perhaps may be called a geometric imagination, an imagination that sees great constructions rather than one that hears beautiful music, conceives of beautiful thoughts, or sees the results of the application of political or business principles; and I am disposed to agree that his training in verbal expression in the schools is not what it should be.

With what seems to me to be a characteristic engineering habit, I would go directly rather than in a roundabout way to the cure of the difficulty. It is more and better English that we want. The study of Latin and Greek will undoubtedly help in securing facility in the use of English, but would it do this to the same degree that an equivalent time spent on the study of English would do?

By all means let us do everything possible in school to give breadth of vision and facility of expression to all students of all professions, but let us not try to make teachers, orators, poets, or story tellers out of those people who, because of their peculiar type of mind, are intended to do the constructional work of the world.

And let us not make too much of the narrowness of vision of the engineer. A considerable experience as an engineer-witness leads me to the conclusion that the average lawyer is not a more logical thinker than the engineer; and long experience in mixing with teachers of language, economics, philosophy, mathematics and all other subjects that are sometimes called cultural leads me to the conclusion that the average teacher of these subjects has a not appreciably greater breadth of vision than the average engineering teacher; and a fortunately limited experience with healers of our bodies and a more or less extended acquaintance with the curers of our souls leads me to the conclusion that neither physi-

...ers nor ministers as a class have a much greater breadth of vision than the engineer.

I think we are inclined to magnify our faults because we are of an analytical type of mind, and it is well that we should see our faults, but let us in characteristic engineering fashion proceed to cure these in the most direct manner. WILLIAM G. RAYMOND,

Dean, College of Applied Science, State University of Iowa.

Iowa City, Iowa.

Flue Lining Would Protect Faulty Chimney

Sir—The fire in the officers' quarters at the United States Army General Hospital No. 3, Colonia, N. J., which is reported in *Engineering News-Record* of May 8, 1919, p. 929, is very much like the reports of a large percentage of the residence fires that are reported from day to day in the daily newspapers: "It started from the chimney." The National Board of Underwriters' reports show from year to year that a larger number of fires, entailing an enormous loss, are caused by defective chimney construction than from any other one known cause.

The materials which this expert brick mason used, in the construction of this particular chimney, would have made a thoroughly safe and satisfactory chimney had the mason looked around a little more and found a few pieces of fireclay flue lining to line the chimney. In all probability, the material was there, because the Government specified such lining in all flue construction at the cantonments. It makes a chimney fireproof and foolproof. The unvoiced criticism of the engineers that the medical officers should not undertake to build a chimney is thoroughly justified, for any of the engineers in the service would undoubtedly have lined the chimneys. G. H. TEFFT,

Secretary and General Manager,

Chicago, Ill. Clay Products Association.

Special Stadia Methods Used in Florida

Sir—On reading the description of the methods used in the stadia survey at Columbus, Ohio, in *Engineering News-Record* of Apr. 17, 1919, p. 776, it occurred to the writer that the methods used by Cunningham and Hallowes, chief engineers of the North St. Lucie River Drainage District, might be of interest to the profession. This district covers 75,000 acres, being approximately 9 x 14 miles in area. As a topographical map was desired on which to base a plan of reclamation, the first move was to run transit and level lines along the section lines the long way of the district, to be used as base lines for the topographical work. Topography parties were made up of five men each: Instrument man, recorder, and three boardmen, it being found that with a party so balanced all hands were kept busy. By working back and forth between base lines, it was not necessary to try for as great a degree of accuracy as would otherwise have been necessary on long traverses.

With this fact in view, instead of setting over the last hub established and continuing the line ahead, the transitman skipped the hub and proceeded to such point as he might select for the next set-up. As azimuths were worked on the full circle, he then set the vernier at zero, dropped the needle, clamped the instrument in meridian, took a back sight reading the azimuth on the "B" vernier, which caused his notes to read as if he had actually set up on the hub and projected the line ahead. This saved the time of one set-up; or, in other words, he made just half as many set-ups as under the old methods, which amounted to a considerable saving in time and expense on a job of this size.

The stadia boards were 14 ft. long and 3 in. wide and were made of cedar at a local boat yard. They consisted of two 7-ft. sections connected with two light strap hinges—two hinges were necessary to overcome a tendency toward side sway. A fish or splice 2 ft. in length was fastened with screws on the back of the top of the bottom section of the rod, in such shape that it extended 1 ft. above and formed a ridged connection when the rod was opened out and fastened with a wing nut.

The first rods tried were graduated in figures the same as ordinary level rods, but on account of low visibility this was abandoned in favor of a character design of yellow, white and black. For the fifth and eleventh foot marks, the white was omitted, the graduations being made in yellow and black for quick identification.

The back of the rod was divided into feet of alternate yellow and black, the fifth and eleventh foot marks being black with a yellow diamond inclosed. It was only used when the sight was obscured or blurred for some reason. Sights of 2000 ft. were frequently made with this rod. This same equipment and methods were used in investigating the drainage outside the district, with very satisfactory results. Considerably more care was taken with the instrumental work, however, and sights were usually confined to about 1400 or 1500 ft. While some of these outside traverses were several miles in length there was no trouble in obtaining proper closures.

The notes were plotted with a universal drafting machine, only the turning points and instrument points being plotted first, to check the closure. As the azimuths were all based on magnetic north, the draftsman set off the variation on his machine and then plotted direct from the notes. After a little practice he was able to transfer the notes to his map about as fast as an assistant could read them.

Fort Pierce, Fla. A. D. CUNNINGHAM.

Chart for Solution of Manning Formula

Sir—Unfortunately, I find that the instructions for the use of my chart for the solution of the Manning formula, reproduced on p. 1126 of your issue of June 5, 1919, were not reproduced. The method of using the chart is as follows:

Starting from the proper value of the hydraulic radius, move vertically to the intersection with the roughness-factor line, then horizontally to the slope line, and vertically to the resultant value of the velocity on the upper scale.

If the desired velocity is known, but not the slope, find the intersections of a vertical line through the proper velocity with a horizonal line through the intersection of the hydraulic radius and roughness-factor lines, and read off the desired slope on the chart.

The following correction should be made: Slope line *s*, numbered 0.00003 on the chart, should be numbered 0.00002. MORTIMER F. SAYRE,

Assistant Professor of Applied Mechanics, Union College.

Schenectady, N. Y.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Flood-Basin Wood Lots Logged For Construction Timber

MODERN forestry, as well as the engineering construction of dams and river channels, is one of the operations which are to make the Miami River Valley of Ohio safe from floods. When 2 x 2 x 24-ft. spuds were wanted for the scows to carry the 200-ton dragline excavators which are widening and deepening the river channel at Dayton, the trees were cut from the wood lots of the conservancy district. This is merely an example. Altogether, some 350,000 ft. b.m. of lumber used in construction, besides over 50,000 lin.ft. of piling and cribbing, have been provided from the same source. In addition, a great amount of timber on the stump has been sold to manufacturers who use mature, high-grade hardwoods in the making of their products. Only matured timber has been cut.

There are about 120 wood lots, varying in area from one acre to 100 acres, in the five large flood-detention basins of the Miami Conservancy District. These wood lots are quite generally distributed, but the greatest amount of timber is in the Huffman and Englewood basins. The Germantown and Taylorsville basins rank next, and the Lockington basin is fifth. All the basins contain about 6,000,000 ft. b.m. of merchantable timber. Nearly all of the timber is hardwood. About 37% is oak and 14% is maple, and there are from 5 to 9% each of ash, birch, elm and hickory. Many of the trees are finely matured specimens of their kinds.

Upon assuming control of the wood lots, the directors of the flood-protection works had careful surveys made and, on the information obtained, a plan of conservation, planting and cutting was mapped out. The theory adopted was that timber was a crop to be harvested when ripe and disposed of for gain. Being a crop, only mature timber, that which would never be worth more than at present, was to be cut. Trees which had not reached maturity were to be left to grow, and growth and quality were to be encouraged by proper thinning out and by the removal of underbrush. In brief, modern, scientific forestry practice was to be applied to the district's woodland properties. This development is making progress, and is to be followed in time by proper planting and reforestation operations suited to the circumstances.

Utilization of the matured timber is the operation of chief interest to the engineer and contractor. Only matured trees, as stated, will be cut. An exception is made to this rule in the cases of wood lots that are on low ground and located not far up-stream from the dams. As a flood which would partly fill the basins would cover these woods and, if the water remained a few days, would probably kill the trees, these low-lying

Other Articles in This Issue of Interest to Contractors:

Large Construction Companies Shun Road Work — Page 1150
Comparison of Blows of Dull and Sharp Drill Points — Page 1152
Mechanical Handling the Feature of Concrete Pile Yard — Page 1155
Labor Turnover High on Two War-Time Contract Jobs — Page 1159
Pneumatic Caissons Sunk Through Moving Ground — Page 1160
Overhead and Time Cost to Erect Elevated Railway — Page 1164

LOGGING WHITE OAK FOR 24 x 24 INCH x 24-FOOT SPUDS FOR DREDGE SCOW ON DAYTON CHANNEL EXCAVATION

woods will be cleared completely. But the utilization will, nevertheless, be thorough. Each size and kind of timber will be turned into the sort and dimensions of lumber for which it is best suited, and the waste of proper size will be prepared and disposed of for fuel. Only the absolutely unmarketable trash will be destroyed by burning.

Specific examples illustrate best the manner of handling the timber crop in the wood lots which will be preserved. Surveys of the wood lots disclosed some 400 or more matured walnut trees; these were sold to a firm manufacturing gun-stocks and to another which makes churns. In the same manner, some 130,000 ft. b.m. of white and blue ash were sold to a firm manufacturing shovel and hoe handles. In all cases, the trees were cut and shipped in the log to be sawed at the factories. For use in constructing the flood-protection works the trees are cut by the district and hauled to conveniently situated commercial sawmills, to be sawed according to orders. For example, the large timbers for scow spuds were hauled to Dayton, where the timber was to be used and where it happened, also, there was the only nearby mill equipped to saw pieces of such large size. The trees were cut by the conservancy logging crew, were loaded onto wagons in the woods and were hauled by a 10-horse team, one log to a load, to a yard on the main road. At the yard the logs were loaded one at a time onto a motor truck and trailer and hauled to the mill. Timber cut from the conservancy woodlands for the conservancy work is charged against the item for which it is used, on the basis of a stumpage price plus the labor cost of producing the lumber. This is, of course, a purely bookkeeping charge.

The forestry work of the conservancy district is directed by J. W. Calland, on leave of absence from the Ohio Forestry Department. S. Graham Smith is director of the district farm lands on which the wood lots are located.

Job Labor Records Kept on Two Forms

TWO card forms kept by the foremen and the job clerk are used for recording time, labor and cost distribution, and payroll disbursements, on concrete-bridge construction at Columbus, Ohio. The bridge is a seven-span arch structure involving the placing of about 18,000 cu.yd. of concrete, with excavation and cofferdam, and also the wrecking of an old bridge structure.

The foreman's card is filled out and turned in daily.

Time Record of Joshua Doe

No. 12 Address 72 Blank St.

WEEK ENDING	S.	S.	M.	T.	W.	T.	F.	TOTAL HOURS	WAGE Per Hour	AMOUNT PAID
Exc	4½	0	3				0	7½	40	3 00
Chev	0	0	6	9	4½	9	0	28½	40	11 40
Equip					4½			4½	40	3 60
Mary			24	19						$18 00

WORKMAN'S TIME AND PAYROLL BLANK, USED ON BRIDGE CONSTRUCTION WORK

Besides the spaces shown for equipment and excavation there are similar spaces for "Concrete, Class A," "Concrete, Class B," "Cofferdam," "Wrecking Old Bridge," "Screening Gravel," and three blank spaces. The workman's card is kept by the job clerk, who enters the figures from the foreman's daily report, as indicated by the sample. From these two original records, cost sheets can be made up and all needed bookkeeping entries made.

The contractors for this work are the Olson-Magee Co. & O. H. Olson, of Kansas City, Mo.

Tractor Pumps Oil from Cars to Tank

BY ALBERT S. FRY
Morgan Engineering Co., Memphis, Tenn.

FIELD tanks which store the fuel oil for the walking dragline excavators which are building levee for the Inter River Drainage District in Missouri are filled by pumping from tank cars by a centrifugal pump operated by a tractor.

To have installed an engine to run a pump to unload tank cars would have been costly. Instead, a small centrifugal pump was set up and, whenever a car is to be unloaded, a tractor is disengaged from some other part of the work and is used to furnish power for the pump. One tractor is used to serve two of the tanks on this work, so this method of operation has been particularly efficient.

The unloading of the oil takes only a small part of the tractor's total time, the greater part being spent in general hauling and right-of-way clearing. On the latter work the tractor has proved its worth in dragging logs out of the cleared area.

OLSON-MAGEE CO. & O. H. OLSON

.....Foreman .....19.....

EQUIPMENT	Laborer's No.																			
	Hours																			
EXCAVATION	Laborer's No.																			
	Hours																			

DAILY REPORT BLANK WHICH IS USED BY THE FOREMAN

NEWS OF THE WEEK

New York, June 12, 1919

Townsend Highway Bill Reintroduced in Congress

The Townsend highway bill, introduced in the last session of Congress and described in *Engineering News-Record* of Feb. 27, p. 446, has been introduced in the present Congress in slightly modified form. The bill has been considerably shortened, and provisions which were in the Federal-aid highway provisions of the Postoffice appropriation bill in the last session have been omitted.

Among the principal changes is the reduction of the number of commissioners from five to three, decreasing their terms from seven to six years. The bill provides that not more than two of the commissioners may be of the same political party. In cases where states have so framed their highway laws that they can take advantage of Federal aid only through the Secretary of Agriculture, he shall act jointly with the proposed Federal Highway Commission in administering the Federal-aid law in those states.

All present Governmental road agencies, with the exception of those pertaining to the War and Navy Departments, are transferred to the proposed new commission.

The officers and salaries provided for in the previous bill are left practically unchanged, as are the appropriations, with the exception that those appropriations for Federal aid provided in the last bill are omitted. All appointees such as clerical or other official assistants, with the exception of the chief engineer, secretary and attorney, shall be taken from the classified civil service; provided, however, that Army engineers may be employed by the commission without civil service procedure. The plan of distribution among the various states, prescribed in the previous bill, is also omitted.

United States Sells Ships at High Prices

Several steel steamers have recently been sold by the U. S. Shipping Board at prices of $210 per dead-weight ton, according to an announcement made by Chairman E. N. Hurley last Friday. A 7500-ton freighter went to the National Shipping Corporation at New York at this figure, and a 5075-ton vessel to the Omega Steamship Co. of the same place; offers for four other ships at the same price have also been received. The Skinner & Eddy Shipbuilding Corporation has offered to buy at present construction costs four 8000-ton freighters being built at the yards of that corporation.

Employment Bureaus

Engineering Societies' Employment Bureau of the four founder societies, conducted by Engineering Council Employment service, for members and for other professional men introduced by members. Especial attention for those released from Government service. Address, 29 W. 39th St., New York City.

American Association of Engineers, 29 S. La Salle St., Chicago. Service to members only, but Army or Navy Engineers in uniform who are eligible to certified membership may join without payment of entrance fees or dues while in uniform and for six months after discharge.

Engineers' Service Bureau, 57 Post St., San Francisco. Only applications by mail or wire will be considered.

Professional and Special Section, United States Employment Service, 469 Fifth Ave., New York City.

Reëmployment Committee of New York City for Soldiers, Sailors and Marines, 233 Broadway, New York City.

Pittsburgh Asks Architects' Aid in Designing Bridges

Three achitects have been engaged by the county commissioners of Allegheny County (Pittsburgh) to act as advisers to County Engineer J. G. Chalfant in the design of three new river bridges which the county is preparing to build. Benno Janssen, of Pittsburgh, will deal with the design of the 40th St. bridge over the Allegheny River (replacing the existing 43rd St. bridge). Alden & Harlow, of Pittsburgh, will serve in connection with the Monongahela River bridge connecting Wilson and Glassport, while Warren & Wetmore, of New York, are retained for the new 16th St. bridge over the Allegheny River. This action follows the recommendation of the Art Commission, concurred in by the planning commission recently appointed by the county commissioners.

Study Missouri River Water-Power in South Dakota

A hydro-electric commission has been appointed in South Dakota, under an act of the legislature, for the purpose of investigating the water-power resources of the Missouri River in that state. This commission has engaged Daniel W. Mead and Charles V. Seastone, consulting engineers, Madison, Wis., to investigate and report.

Trouble With Bascule Bridge in Buffalo

Partial dropping of a bascule bridge in Buffalo recently, which blocked the span for a time, was caused by the operating gearing getting out of mesh. George H. Norton, city engineer, describes the circumstances as follows:

The South Michigan Ave. bridge over the city ship canal is a rolling-lift span of 110 ft., erected in 1904. The rolling girders or segments have shoe plates of 2-in. rolled steel which were bent and turned in a lathe to 20-ft. radius and have mortise holes which engage with lugs on the cast-steel track plates on the foundation girders. These rolled shoe plates had cracked and broken out around the lugs so as to allow the structure to shift in position.

Endeavor was made to have new plates constructed for this purpose, but as this type of bridge is now using cast-steel segmental shoes for this purpose, after consideration it was decided to repair the plates by the electric welding process. This work is now under way. The shifting of the span on its track plates somewhat racked the operating machinery so as to allow the operating gear to slip, allowing the span to drop a short distance, but without injury to the span itself. The shifting in position made it impossible to land the span for a time and also impossible to operate it until the machinery gearing had again been placed in mesh. The most serious difficulty has been from delay to navigation for several short periods in the adjustment of the operating machinery.

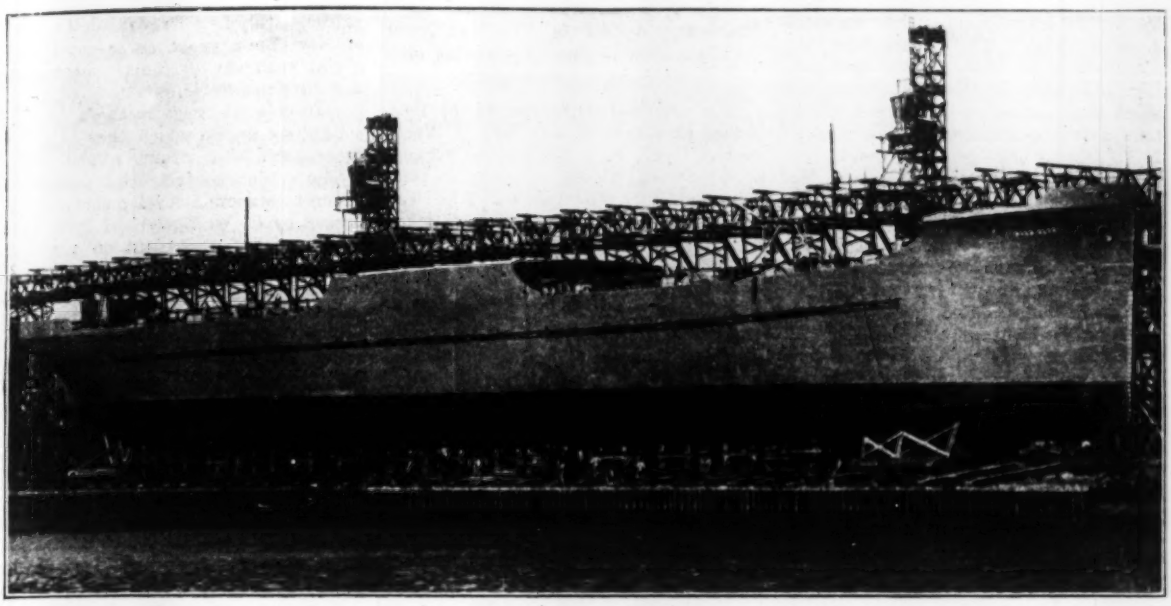
First Iowa Road-Bond Vote Under New Law Favorable

As a result of the favorable vote, June 3, on a $1,500,000 bond issue, the entire primary road system of Black Hawk County, Iowa, consisting of 84 miles, is to be paved. Black Hawk, in which Waterloo is situated, is the first county to hold an election under the new law. The fact that Iowa roads have been practically impassable this spring is reported to have had its effect on the vote.

Combined Dues Plan Operative

The Cleveland Engineering Society has approved the proposal that there be a reduction in the combined dues of members of the Cleveland Engineering Society and the American Society of Mechanical Engineers. The governing board of the latter body had already approved the plan, so it is now operative.

Largest Concrete Ship Launched at San Francisco



7500-TON CONCRETE OIL TANKER LAUNCHED SIDEWAYS AT SAN FRANCISCO MAY 29

The first of the Government's 7500-ton reinforced-concrete oil tankers, the largest concrete vessels ever attempted, was launched May 29 from the Government Island yard of the United States Shipping Board, on San Francisco Bay. The vessel was launched 90% complete and was put in 94 days after the date of the first concrete pouring. The actual pouring of the concrete was completed in about two weeks. The vessel's dimensions are: Length, 435 ft.; beam, 54 ft.; depth, 36 ft. The design was described in *Engineering News-Record* of Nov. 28, 1918, p. 986. R. J. Wig, chief of the concrete division of the United States Shipping Board, was present at the launching and Mrs. Wig christened the ship, which has been named "Palo Alto."

New State Highway Engineer Appointed by Kansas Commission

Appointment of a new state highway engineer has been announced by the Kansas Highway Commission. He is M. W. Watson, who has served as acting state highway engineer since July 15, 1918, in the absence of W. S. Gearhart in Army service. A large amount of road construction is in progress and more is planned, which will be directly under the supervision of Mr. Watson.

Before entering the service of the state, Mr. Watson practiced engineering in connection with coal mining, railroad work and municipal work in southeastern Ohio. He also served in the civilian branch of the United States Army in connection with the improvement of the Ohio River. For five years previous to entering the service of the Kansas Highway Commission as road engineer, in 1917, he served with the Illinois State Highway Department. He is a graduate in civil engineering from the Ohio State University.

Semi-Annual Meeting of Chemical Engineers

At the 11th semi-annual meeting of the American Institute of Chemical Engineers, to be held at the Hotel Lenox in Boston, June 18-21, a symposium on electric furnaces is planned for practically the whole of the opening day. Moving pictures of the operation of the furnaces are to be shown. A symposium on the registration of chemists will be held, and on the last day of the meeting the textile mills in Lawrence will be visited.

May Shipbuilding a New Record

Deliveries of completed ships in May passed all previous records, according to figures made public by J. L. Ackerson, vice-president of the Emergency Fleet Corporation. Moreover, for the first time since the beginning of the corporation's work deliveries exceeded launchings. Diminution of ship production in the early future is indicated by the fact that, considering steel construction only, fewer keels were laid than hulls launched or vessels delivered during the month.

During May, 136 ships totalling 768,025 dead-weight tons were delivered, completed, as against 111 ships of 543,720 tons in April. In both months the largest part of the tonnage was made up of steel ships, of which 87 (594,425 tons) were delivered in May, and 76 (423,320 tons) in April. The launchings for the two months were: May, 137 vessels (including 82 steel) of 705,958 tons; April, 118 vessels (including 74 steel) of 586,266 tons. Keel-layings amounted to 80 (all steel) in May, and 84 in April (including three wood), but the tonnage represented by these keels is 12% larger for May than for April.

Hurley Gives Average Cost of Shipbuilding

Gross Cost, Excluding Plant Extension and Housing Is Further Reduced by Profit Tax Payments

Shipbuilding cost figures for the vessels under construction by the Emergency Fleet Corporation were presented to the public during the past week, for the first time. In a published letter to Representative James W. Good of the House Appropriations Committee, Chairman Edward N. Hurley of the Shipping Board gives the net cost of the Fleet Corporation's ships at about $180 per ton.

In all, Congress has authorized the appropriation for shipbuilding purposes of $3,671,000,000, but of this only $2,625,451,000 has actually been appropriated. The board will require $673,368,301 additional, making a total ultimate expenditure of $3,298,819,301. Of this sum, a total of $202,853,456 should be charged off as representing not the cost of completed ships, but the loss involved in canceling contracts for 754 ships (which would have cost $797,564,276 to complete). Furthermore, shipyard plant extensions, shipworkers' housing and transportation costs amounted to $189,210,275, which is not a direct shipbuilding cost. Similarly, the administration cost of the board and the Fleet Corporation, amounting to $35,000,000, is not to be charged

against the ships. Thus, a total deduction from the gross expenditure should be made in the amount of $437,063,731, leaving the actual money spent for ships $2,861,755,570. This represents the construction of 2434 vessels aggregating 13,885,106 dead-weight tons, the ships thus averaging 5700 dead-weight tons carrying capacity and a cost of $1,175,000, or $206 per dead-weight ton.

As an offset against this cost Mr. Hurley cites the large income and excess profits taxes paid by shipbuilders on the profits of ship construction. Some shipbuilders, he says, have paid such taxes to the amount of $40 per ton; he estimates $25 a ton as the average tax payment of this kind by all shipbuilders, which indicates that very large profits were made by the yards. As far as the Government account is concerned, he reckons this $25 a ton as a deduction which, however, should still further be increased by the taxes paid by the many concerns that supplied steel, boilers, engines and other ship equipment, the amount of these taxes not being known. He concludes that, deducting $25 from $206, the balance of about $180 per ton is an outside figure for the actual cost to the Government of the Emergency Fleet Corporation's ships.

Southern Asphalt Association Formed by Contractors

The Southern Asphalt Association, comprising the principal public-works contractors engaged in laying asphalt pavement in the South Atlantic states, on June 1, opened offices in Atlanta, in the Healey Building. The association will be conducted in the interest of the construction of asphalt roads and pavements in the South Atlantic states.

The following officers have been elected: President, Walter Ely, of the Ely Construction Co., Augusta, Ga., and vice-president, W. R. Mayrant, general manager of the Simmons-Mayrant Co., Charleston, S. C. J. M. Woodruff, who resigned recently as manager of the advertising and paving department of the Standard Asphalt & Refining Co., of Chicago, is general manager.

Propose 385-Foot Concrete Arch

Tentative plans for a bridge across the Willamette River at Oregon City, prepared by the Oregon State Highway Department, show a main crossing consisting of a concrete and steel arch of about 385 ft. clear span, with a 120-ft. rise, flanked by reinforced-concrete approach spans, the entire structure being about 1000 ft. in length. According to a statement just issued, it is contemplated using in the main span a fabricated structural steel rib incased in a protective coating of concrete. In one of the drawings the approaches are of a Roman-arch viaduct type; that is, with multiple arches in vertical elevation. The bridge has been designed by C. B. McCullough, state highway bridge engineer, under the direction of Herbert Nunn, state highway engineer.

Second Pan-American Commercial Conference Meets

Necessary Action to Produce Closer Coöperation Discussed—Bearing of Engineering Considered

A commercial conference of the Pan-American countries was held in Washington, D. C., June 2-6, for the purpose of producing closer commercial relations among the various American countries. Many addresses were made in advocacy of better lines of communication and better commercial relations, and emphasizing the trade opportunities in South America. The afternoon of June 5 was devoted to the discussion of "Engineering and Its Significance and Relation to Commercial Developments."

William C. Redfield, secretary of commerce, in addressing the conference, announced that he had recommended to the United States Shipping Board the establishment of two new trade shipping routes to South America, one along the eastern and northeastern coasts, the other along the northern coast. He stated that these would serve to provide intercommunication among the South American countries as well as to carry American commerce. The Chilean ambassador, Señor Don Beltram Mathieu, called attention to the necessity for firm commercial ties as a means of building up sound diplomacy. He declared that the security of justice, of good order, of good faith in the observance of agreements are as indispensable as cheap production, transportation or credit. The Bolivian minister, Señor Don Ignatio Calderon, emphasized the need of South America for North American capital to develop its resources. In speaking of Mexico, Speaker Gillett of the House of Representatives laid stress upon the production of better conditions in Mexico as an essential to the best interests of all the American countries and of greatest interest to Mexico herself.

Chairman Edward N. Hurley of the United States Shipping Board aroused great interest while explaining the plans of the board to develop better shipping facilities to South America. Many questions were asked, and he stated that an initial trip is proposed for about Nov. 1. He assured the audience that no country would be neglected in the program, which would be developed for the best interests of all.

The engineering session was presided over by H. C. Parmelee, editor of *Chemical and Metallurgical Engineering*, and the session considered railways, highways, aërial tramways, light railways, and sanitation.

The railway discussion was introduced by Percival Farquhar, of New York, who devoted himself to a broad consideration of the question. Charles F. Lang, of Cleveland, Ohio, sent a paper on light railway transportation systems. Charles Whiting Baker, consulting editor of *Engineering News-Record*, New York, presented the subject of highways, and indicated their importance as railway feeders when arranged as systems radiating from railway stations. Dr. Walter C. Kretz, of New York, spoke on the use of the aërial tramway systems, pointing out the fundamental limitations of transportation with such methods and the conditions under which they might be constructed with profit.

The subject of irrigation and its relation to economic development was discussed by C. W. Sutton, of New York. The need for agreement on a number of technical engineering ideas now expressed in different Latin-American countries by a variety of words was brought out by V. L. Havens, editor of *Ingenieria Internacional*. Maj. George A. Soper, Sanitary Corps, U. S. A., advocated a definite plan to be adopted by municipalities in their program for community sanitation.

The principal proposals of the conference may be summarized as follows:

1. Immediate establishment of abundant freight, mail and passenger steamship facilities between the United States and Latin America.

2. Making of every effort by both governments and individuals to develop thorough reciprocity and mutual coöperation.

3. Meeting of the unavoidable and pressing financial needs of the Latin American governments and legitimate private undertakings, and also the protection and enlargement of the United States-Latin America trade.

4. A well defined program for the protection of the patents, trade-marks and copyrights of each country in all the other twenty countries.

5. Making of the parcel post beneficial alike to the United States and Latin American peoples, through the removal of unnecessary restrictions and regulations.

6. Improvement in the administration of the consular services.

7. Undertaking, without delay, all over Latin America, of extensive railway and highway construction.

8. Better credit facilities for Latin American buyers, closer study of Latin American trade, and the extension of United States banking connections.

9. Improvement and extension of news and commercial intelligence service.

The discussions will appear in English in the proceedings of the Pan-American Commercial Conference soon to be published by the Pan-American Union. The papers read at the engineering session will appear in Spanish in the July number of *Ingenieria Internacional*.

Lack Material for Economical Road Construction in Texas

With large amounts of money appropriated and the material plants in Texas working now at full capacity, there are insufficient aggregates in the state to carry on road work in an advantageous manner, according to R. J.

Windrow, state highway engineer. It is asserted that there are not over five quarries and 15 gravel pits operating that can deliver materials in large quantities. If it were not for local materials the outlook in the state would be discouraging.

Materials are plentiful in the state, according to the engineer, but capital seems unwilling to invest in plant equipment. Already the counties of the state have voted about $50,000,000 in bonds, with $22,000,000 more pending, the Federal Government has allotted $16,000,000 in Federal aid, to which the State Highway Department will add $2,800,000, and a constitutional amendment authorizing $75,000,000 for road purposes will be voted on in the autumn.

The highway department believes that the material business should be profitable, considering these large amounts of construction.

Commerce and Engineering Colleges Merged in Cincinnati

It is officially announced by the University of Cincinnati that the College of Commerce has been merged with the College of Engineering, under Dean Herman Schneider. Beginning next autumn a five-year coöperative course in commerce and administration will be offered. This course is planned to meet the demand for men trained both in the production and the commercial sides of business enterprises.

Dean Schneider thus describes the new course:

"The general plan is the same in detail and operation as in the coöperative course in engineering—that is to say, students will work alternating biweekly periods at practical work in business concerns and theoretical work in the university.

"The practical work during the first year will be in certain carefully selected departments of production, in the shipping departments of large concerns, in the traffic departments of railroads, and in the planning departments of factories.

"The work will cover a period of about 2½ years, after which the student will be transferred to the commercial side of business for the next two and a half years."

Enormous Increase in Exports

April exports passed the previous high record by nearly $100,000,000, according to a report issued by the Bureau of Foreign and Domestic Commerce, Department of Commerce. The figures given for exports and imports are as follows:

Exports	
January, 1919	$623,000,000
March, 1919	605,000,000
April, 1918	501,000,000
April, 1919	715,000,000
Past 10 months	5,705,000,000
Similar period 1918	4,844,000,000
Imports	
April, 1919	273,000,000
March, 1919	268,000,000
April, 1918	279,000,000
Past 10 months	2,474,0000,00
Similar period 1918	2,362,0000,00

Engineering Educators to Meet

At the annual meeting of the Society for the Promotion of Engineering Education to be held at Johns Hopkins University, Baltimore, Md., June 25-28, each half day's session will be devoted to some special topic, as follows:

At the first session, report of a special committee on the Mann report of the Joint Committee on Engineering Education; also papers on the "Case System for the Study of Law" and "Mental Tests for Engineering Students." At the second session, symposium on the effect of war on engineering education, opened by Anson Marston, dean of Iowa State College, also a paper on "The Unconscious Plagiarist," by G. I. Mitchell of the University of Pittsburgh. At the third session, military training in engineering schools, introduced by Col. W. S. Morrow, and by President Charles S. Howe of the Case School of Applied Science. At the session Friday morning the past and future of the society will be discussed by George R. Chatburn, past president, and in the afternoon the United States Naval Academy and Engineering Experiment Station at Annapolis will be inspected. At the last session there will be a symposium on changes in engineering courses, introduced by Dean Gardner C. Anthony, Tufts College, who will speak on the new course at that institution.

Protest Against Fishing in Water-Supply Reservoirs

Members of the New England Water-Works Association, called together on short notice, held a conference in Boston, recently, to discuss measures for opposing the passage of a bill which would make it lawful to fish in ponds used for water-supply in Massachusetts. Letters were prepared to be sent to all water boards in the state.

Civil Service Examinations

California.—Civil engineer, grade IV, $2700 to $3900 per year; examination in Sacramento, San Francisco and Los Angeles as soon after June 14 as possible. File applications with State Civil Service Commission at Sacramento before June 14.

California.—Construction engineer (civil engineer, grade III), $2100 to $2700 per year; examination in Sacramento, San Francisco and Los Angeles, June 20. File applications with State Civil Service Commission at Sacramento before June 14.

California.—Civil engineer, grade II, $1500 to $2100 per year; examination in Sacramento, San Francisco and Los Angeles, June 20. File applications with State Civil Service Commission at Sacramento before June 14.

California.—Senior engineering draftsman, grade II, $1500 to $2100 per year; examination in Sacramento, San Francisco and Los Angeles, June 20-21. File applications with State Civil Service Commission before June 14th.

New York.—Heating and ventilating engineer, office of state architect, $1500 to $2500 per year, June 28, apply to State Civil Service Commission at Albany for application forms before June 16.

United States

For United States civil service examinations, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local office of the commission, for form 1312.

Senior engineer and senior architect, Interstate Commerce Commission, $1800-$2700 per year, June 10. File application before June 10.

Assistant designing engineer, Naval Ordnance Plant, South Charleston, W. Va., $9.20 per diem. July 8. File applications before July 8.

Valuation engineer, $3600-$4800 per year, and assistant valuation engineer, $2500-$3600 per year; technical staff, income-tax unit, Bureau of Internal Revenue, Treasury Department. No date specified.

Master computer, $2400 to $1800 per year, computer (Grade I) $1800 to $1400 and computer (Grade II) $1400 to $900, Ordnance Department. Applications will be received until further notice.

Assistant inspector of engineering material (aircraft), $5.92 per diem, July 15. File applications before July 15.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, 29 W. 39th St., New York; June 16-19, Detroit.

AMERICAN SOCIETY OF CIVIL ENGINEERS; 29 W. 39th St., New York; June 17-20, St. Paul-Minneapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS; University of Pennsylvania, Philadelphia; June 24-27, Atlantic City, N. J.

AMERICAN CONCRETE INSTITUTE; 6 Beacon St., Boston; June 27-28, Atlantic City, N. J.

The San Francisco Association of Members of the American Society of Civil Engineers held a meeting May 26 which was devoted to considering the work of the Committee on Development. Four committees had previously been appointed, each assigned to one of the four subjects given to subcommittees of the Committee on Development, and the reports of these four committees were printed and sent to members of the San Francisco Association, so that all might be prepared

to pass on the recommendations of the several committees. To expedite matters, each of the four committee chairman was made chairman of the meeting pro tem, during the discussion of the report of his committee. These men were Edwin Duryea, subcommittee No. 1; C. J. Rhodin, subcommittee No. 2; C. E. Grunsky, subcommittee No. 3; George L. Dillman, subcommittee No. 4. There was a lively discussion, which considered the subjects from many angles and served to provide H. L. Haehl, the association's delegate to the Committee on Development, with a comprehensive idea of the members' viewpoints. A stenographic report of the discussion was taken for reference.

The Colorado Association of Members of the American Society of Civil Engineers will hold its annual meeting at the Shirley Hotel, Denver, June 14. The regular business of this meeting, such as the election of officers, hearing the president's annual address, and reports of the various officers, will be taken up. In addition, there will be an address by E. A. Moritz, engineer, United States Reclamation Service, on "A Public-Works Department for the Federal Government." The usual informal dinner will precede the meeting.

The Rochester, N. Y., Society of Technical Draftsmen will hold its annual meeting and election of officers at its rooms in the Sibley Block, 328 Main St., East, on June 26, 1919. Among the addresses will be one entitled "Some Experiences in Construction Work in the Tropics," by Leslie S. Wood, of the Eastman Kodak Company.

The Houston Engineers' Club and local members of the American Association of Engineers held a joint meeting May 26 at which C. E. Drayer, national secretary of the association, explained its principles and work. Officers of the club asked for a proposal under which it might become a part of the association. The club is one year old and has one hundred members, the number of engineers in its district being three hundred. In a discussion on licensing, J. M. Howe stated that an effort would be made to have a law passed at a special session of the legislature which meets this month. Maj. J. A. Rossiter suggested that the club direct the formation of a city-planning commission. A plan will be the subject discussed June 12. J. C. McVea, city engineer, is president of the club.

The Southwestern Society of Engineers held a convention at El Paso, Tex., on May 29-31, 1919, at which topics of general interest to engineers were discussed. Among the addresses and speakers were: "Oil Geology," by G. M. Butler, dean of the School of Engineering, University of Arizona; "Licensing of Engineers," by C. E. Drayer, secretary of the American Association of Engineers, of Chicago; "The Concrete Ship," by C. E. Barglebaugh, former engineer, Emergency Fleet Corporation, and "Modern Wireless Telegraphy and Telephony," by R. W. Goddard, in charge of the school of radio engineering, New Mexico Agricultural and Mechanical College. The officers for the previous year were re-elected.

The Rochester, N. Y., Engineering Society will hold its annual meeting June 13, 1919, at the Hotel Seneca. This will be the last get-together meeting of the season. An informal dinner at the Hotel Seneca will be followed by the election of officers and committee reports, and by an address by J. Y. McClintock, superintendent of highways, Monroe County, on "The Finger Lakes Road Project and the Roosevelt Road."

The Associated Engineering Societies of St. Louis held a joint meeting at the Engineers' Club, under the auspices of the St. Louis Section of the American Society of Mechanical Engineers, June 5. Wallace C. Capen, St. Louis manager, the White Co., gave a talk on "Certain New Developments in Rear Axle Construction." Motion pictures and lantern slides of motor-truck performance in Mexico and France were shown.

The Canadian Society of Domestic, Santiary and Heating Engineers held its annual convention at Montreal June 4-5, 1919. Reports were presented concerning the laws regarding plumbing and sanitation in the various provinces, with the object of formulating model laws to regulate these matters. The following officers were elected: President, F. R. Maxwell, of Toronto; secretary, G. F. Frankland, of Toronto.

The Louisiana Engineering Society held its regular meeting in the library room of the State Museum Building, New Orleans, June 9, 1919. Among the addresses was a paper by Thomas L. Willis on "Garbage Disposal."

PERSONAL NOTES

E. C. EARLE, designing engineer, Bureau of Public Works, Manila, P. I., has been appointed chief designing engineer of the bureau and is now engaged in carrying out the design and construction of a new ocean terminal pier and the enlargement and alteration of several of the older structures at the port of Manila.

C. C. THOMAS, formerly sales engineer of the Denby Motor Truck Co., has been appointed chief engineer of the Fields Manufacturing Co., Owosso, Mich. Mr. Thomas has been identified with several branches of work in the automotive industry, being successively in the experimental engineering department, service manager and sales engineer.

MAJ. THOMAS G. HAMILTON, formerly a construction engineer at Gary, Ind., who has been a member of the general staff of the American Expeditionary Forces, has been promoted to the rank of lieutenant colonel and has received the decoration of the Cross of the Legion of Honor from the French Government. He expects to return to Gary in July, upon his release from the service, and resume his work with the T. G. Hamilton Construction Company.

DAVID MACNAUGHTON has opened a consulting engineering office at 528 Lincoln Life Bldg., Fort Wayne, Ind., for the practice of industrial engineering, including the making of illumination surveys, valuations, reports and rate investigations of electric light and power companies. Mr. MacNaughton has been engaged in public utility engineering for the past 12 years for large companies operating in Indiana, Illinois, Michigan, Ohio and Wisconsin. He has also had wide experience in valuation work, making reports and analyzing rate charges for electric light and power service.

P. B. MCDONALD, who has been head of the department of engineering English at the University of Colorado for the past two years, has been appointed assistant professor of English in the engineering college of New York University.

H. F. HARMON and J. H. SLUSS, of Graham, Va., have formed a partnership and will carry on the construction work formerly handled by the J. H. Sluss Construction Co., of Graham, Va., and Huntington, W. Va. Mr. Harmon has had long experience in the construction business, as superintendent and manager of large construction companies, while Mr. Sluss is a civil engineer with varied construction experience, particularly in railway construction.

B. H. FRASER, formerly assistant chief engineer of the Department of Marine, Ottawa, Canada, has been appointed chief engineer, succeeding COL. WILLIAM P. ANDERSON, retired.

W. J. KRULL, HOWARD T. KRULL and HOMER B. GRADLE, of Hobart, Ind., have organized a construction company, to be known as the TRIANGLE CONSTRUCTION CO., with offices in the American Trust & Savings Bank Building. They will both make plans as architects and do construction work.

ERNEST P. GOODRICH, consulting engineer, announces the removal of his office to 140 Nassau St., New York City.

HOLLIS LIBBY, county surveyor of Lane County, Oregon, has resigned to accept a position as engineer with the State Highway Commission. Mr. Libby has served as county surveyor for the past six years, with the exception of the past nine months, while he was in the Army service.

PAUL SUMMY, city engineer of Warsaw, Ind., has resigned to devote his entire time to his business interests.

P. F. WHITTIER has resigned as engineer for the Whittier Mills Co.,

Chattahoochee, Ga., to accept the position as assistant to the State Highway Engineer, W. R. NEEL. He will take charge of the excess War Department equipment allotted to Georgia for Federal-aid highways.

LIEUT. COL. ARTHUR H. PARKER, of Cody, Wyo., who has recently returned from overseas service with the Quartermaster Corps of the 32nd Division, has been appointed assistant engineer, State Highway Department.

A. W. MOSELEY, of Kansas City, Mo., has been appointed by Col. E. M. STAYTON as his assistant in building the road system of Clay County, Missouri.

G. SYVERSEN and C. KRUSE, New York City, severed recently their connection with the ROBINS CONVEYING BELT CO., and sailed, June 9, for Christiania, Norway, where they will form a partnership to practice industrial engineering They will also represent the company in Norway.

T. R. SPENCE, formerly with the engineering department of the Army, has been appointed by the State Highway Department as superintendent of the surplus Federal equipment allotted to the State of Texas for Federal-aid road work.

CAPT. RICHARD SCHERMERHORN, of New York, of the Engineering Section, Sanitary Corps, American Expeditionary Forces, has received his discharge from the service and has resumed his practice as landscape architect and civil engineer at 363 Lexington Ave., New York City.

CHARLES CURRY, Kansas City, Mo., who served as a lieutenant with the 110th Engineers in France, has been appointed assistant city engineer of Kansas City, Mo. Before entering the service he was assistant in the sewer-engineering division of the city.

COL. E. M. STAYTON, of the 110th Engineers, has received his discharge from the service and has been engaged by Clay County, Missouri, to supervise building of its road system. Colonel Stayton was formerly highway engineer for Jackson County, Missouri.

CAPT. J. H. BONNER, Engineers, U. S. A., has received his discharge from the service and has been appointed chief engineer of the Montana Railroad and Utility Commission, Helena, Mont. Before entering the service Captain Bonner was a member of the staff of the College of Engineering, University of Montan

TAYLOR A. BORRADAILE, of Charleston, W. Va., has been appointed city chemist, and will take charge of the chemical and bacteriological research department of the city government. For the past two years he has been with the chemical department of the Warner-Klipstein Chemical Co., of South Charleston.

FRANK E. BAKER, engineer in charge of construction for Methodist Episcopal projects in Europe and North Africa, left, June 5, for France to begin work on the 11 towns of the Chateau-Thierry battlefield which have been assigned to the Methodist Episcopalians for reconstruction. He will supervise a five-year building program, which will include the erection of sixty permanent buildings in France and about the same number in Italy.

H. H. ESSELSTYN, commissioner of public works of Detroit, Mich., has resigned, to take effect June 30, to return to the firm of ESSELSTYN, MURPHY & HANFORD, engineers and architects, 810 Marquette Building, Detroit. His resignation was made necessary by the increased scope of the work of the company

H. H. FILLMORE, formerly resident engineer with the Los Angeles, Calif., Highway Commission, has been appointed district engineer in charge of the Los Angeles office of the Portland Cement Association, in the Merchants' National Bank Building. He will have charge of the association's activities in Southern California and Arizona.

HERBERT J. FLAGG, Coast Artillery, U. S. A., has recently received his discharge from the service and has returned to his former position as assistant engineer, Public Service Commission of the State of Washington, at Olympia, Wash.

LIEUT. C. B. LEWIS, recently discharged from command of Co. C, 217th Engineers, has accepted a position as sales engineer with the Northwestern Expanded Metal Co., of Chicago. Before the war he was superintendent with Albert Kahn, architect, of Detroit.

J. R. ROBERTS has been appointed chief engineer of the Central Illinois Public Service Co., with headquarters at Mattoon, Ill.

O. B. KERCHER, formerly assistant to D. MOOMAW, county road engineer of St. Josephs' County, Indiana, has resigned to join the forces of the Indiana State Highway Commission.

LIEUT. COL. AMOS A. FRIES, Engineers, U. S. A., who was a brigadier general in charge of the Chemical Warfare Service of the American Expeditionary Forces, has been made a Commander of the Legion of Honor by the French Government.

CHARLES F. O'HAGAN, formerly chief engineer of the William B. Scaife & Sons Co., Pittsburgh, has been appointed resident engineer and manager of the Chicago office of the company, at 38 S. Dearborn Street.

JAMES W. TOWNSEND has opened an office at 709 Empire Bldg., Detroit, Mich., for practice as a designing and construction engineer. He is at present building a theater at River Rouge, Mich.

JOHN H. BRINGHURST, associate professor of civil engineering, Johns Hopkins University, has accepted the position of dean of the faculty and professor of engineering design at the Drexel Institute, Philadelphia. Professor Bringhurst is a graduate of the University of Michigan, and since graduation has had a varied experience in structural engineering. He has been associated with Johns Hopkins University since the autumn of 1916.

HENRY B. SEAMAN, supervising engineer, Navy emergency plant extensions, Bureau of Yards and Docks, terminates his connection with the bureau June 15. While with the bureau Mr. Seaman has had general supervision, under Admiral Rousseau, of construction work at 35 shipbuilding and accessory plants throughout the country. The work supervised has cost more than $55,000,000. Mr. Seaman was formerly chief engineer of the New York Public Service Commission, First District. He will return to New York, and his temporary address will be 363 Grand Ave., Brooklyn, N. Y.

E. J. TESKEY, of South Bend, Ind., has been appointed assistant to D. MOOMAW, county road engineer of St. Joseph's County, Indiana, with office in South Bend.

C. J. RENNER, of Mount Vernon, N. Y., has been appointed city engineer of Ellwood City, Penn., succeeding ALEXANDER MAINES, who has resigned.

FRED G. SIMMONS and JOHN C. DAVIS have formed a partnership as consulting engineers, with offices at 811 Majestic Building, Milwaukee, Wis., for the carrying on of a general engineering business. Mr. Simmons was formerly commissioner of public works of the City of Milwaukee and engineer of construction and maintenance for the Milwaukee Electric Railway & Light Co. Mr. Davis was dean of the College of Applied Science and Engineering at Marquette University and director of the Bureau of Municipal Research of the City of Milwaukee.

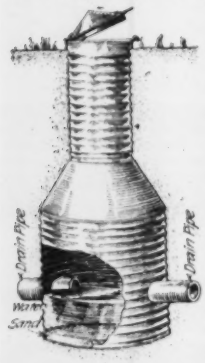
OBITUARY

FREDERIC A. BIGGI, highway contractor and civil engineer, of Albany, N. Y., died in that city, May 31. He was graduated from the Massachusetts Institute of Technology in 1904, and was connected with work for the Public Service Commission, First District, New York State Barge Canal, and New York State Highway Department for a number of years. For the past four years he was engaged in the construction and repair of highways.

EDWARD F. MULLANEY, an assistant engineer in the city engineering department of Minneapolis, Minn., died in that city, May 21, at the age of 64. He had been in the service of the city for the past 34 years.

Corrugated-Iron Manhole Sand-traps for Tile Drains

A new form of corrugated-iron combination manhole and sand-trap, for use in tile drainage on irrigation work and elsewhere, was described by L. E. Thompson, irrigation expert, in the June issue of the *Highway Magazine*. This method of access to the underdrainage system is formed by joining convenient-sized sections of circular corrugated-iron pipe. Many desirable features of this device are mentioned by the writer; some of them are as follows:



COMBINED MANHOLE AND SAND-TRAP

Combination manhole and sand-traps, extending about 1 ft. below the drains, serve as a settling basin for any sand or silt which may pass through the pipe; provision can always be made for flushing the drain, which is an important feature; the sizable opening at the top provides a means for operating a root-cutting or drain-cleaning device; and the manhole may be utilized to carry off surface water, thus serving a double drainage purpose.

The device as described by Mr. Thompson is about 10 ft. deep, 2 ft. wide in the neck, 4 ft. at the bottom and made of "Armco" pipe. An iron top is provided, as shown in the cut, and the device can be supplied with or without an iron bottom.

Good Roads Show and Exposition To Be Held in South Carolina

The Southeastern Good Roads Show and Agricultural Implement and Tractor Exposition will be held at Greenville, S. C., July 14-19, 1919. In addition to addresses by prominent road officials and highway transportation enthusiasts, there will be a complete exhibit of all kinds of roadbuilding and agricultural implements and machinery. The general manager is F. M. Burnett, of Greenville, S. C.

Large Weld Repairs Stern Frame of "Northern Pacific"

Welding of the large stern frame of the U. S. A. transport "Northern Pacific," which was broken just above the rudder lug when the steamer went upon the beach off Fire Island, New York, last January, has been accomplished by the Metal & Thermit Corporation, of New York. The section welded was entirely broken through as a result of the severe strain when the boat went aground with its load of homeward-bound troops.

The weld required 1400 lb. of thermit for the production of the necessary amount of molten metal, and the operation was performed without removing the casting from the ship. This obviated the delay and expense which would have been entailed by the only alternative of purchasing an enormous new casting and installing it in the "Northern Pacific."

BUSINESS NOTES

THE LEHIGH PORTLAND CEMENT CO., of Chicago, announces the appointment of C. B. Rogers as assistant treasurer and credit manager in place of W. E. Viets, who has resigned.

THE MASSEY CONCRETE PRODUCTS CORPORATION, Peoples' Gas Building, Chicago, announces the appointment of P. E. Longstreet as resident manager of the Western district, in charge of all sales in that territory. His headquarters will be at 925 S. 6th St., West, Salt Lake City, Utah.

L. V. ESTES, INC., industrial engineers and accountants, have removed their offices from the McCormick Bldg., to the Century Bldg., 202 S. State St., Chicago, Ill., where they will occupy the entire fifteenth floor.

THE STARK ROLLING MILL CO., of Canton, Ohio, announces the appointment of George W. Scott as district manager for the Chicago territory, with headquarters at 1119 Marquette Bldg. Mr. Scott was formerly Chicago representative of the Pittsburgh Steel Co. The company also announces the appointment of Thomas F. Murphy as district manager for the Canton, Ohio, territory. Mr. Murphy was formerly connected with the American Sheet & Tin Plate Company.

THE MANUFACTURERS' CO., of San Francisco, has opened an office at 811 Lumber Exchange Bldg., Chicago. B. F. Wade, formerly chief engineer of the Redwood Manufacturers' Co., now represents the company in the Chicago office.

THE AMERICAN BLUEPRINT CO., of Chicago, Ill., announces that Vernon T. Brauns, for the past four years salesman for the company, has been made manager. Mr. Brauns has been active in the American Association of Engineers and the Western Efficiency Society, and is well known among railroad valuation engineers for his promotion of a process for reproducing tracings for presentation to the Interstate Commerce Commission.

THE VAN DORN & DUTTON CO., of Cleveland, Ohio, manufacturers of gears and pinions for electrical work, has opened branch offices in New York and Chicago. Harry S. Keegan, formerly with the Chicago surface lines, will manage the Chicago branch, with offices at 1241 First National Bank Building. John Keegan, formerly with the Interborough Rapid Transit Co., of New York, will manage the New York office, which will be at Room 312, 30 Church Street.

THE DAYTON INSULATING DIE CO., U. B. Building, Dayton, Ohio, manufacturers of molded insulation products and dies for the same, has bought the Edgemont Die Castings Co., of Dayton, Ohio, and will consolidate it with its other plants, operating under a new name. E. A. Kurz will be president. A new plant, 60 x 120 ft., and two stories high, will be immediately erected at Edgemont, Ohio.

TRADE PUBLICATIONS

The following companies have issued trade publications:

THE IRVING IRON WORKS CO., of Long Island City, N. Y.; catalog, 4½ x 8½ in., 36 pages, illustrated; descriptive of "Irving Subway Fireproof Ventilating Flooring."

THE BELMONT IRON WORKS, 22nd St. and Washington Ave., Philadelphia, Penn.; catalog, 14 x 8½ in., 16 pages, illustrated; an export catalog printed in three languages, English, French and Spanish; describes the plants and products of the works and gives weights and dimensions of various steel sections.

THE GENERAL FIREPROOFING CO., Youngstown, Ohio; pamphlet, 8 x 11 in., 16 pages, illustrated; gives data on waterproofings, damp-proofings and technical paints.

THE AMERICAN SPIRAL PIPE WORKS, Chicago, Ill.; catalog, 8 x 10½ in., 87 pages, illustrated; describes and illustrates the advancement in the manufacture of corrugated-steel furnaces, large-diameter lap-welded steel pipe, spiral-riveted pipe, forged-steel flanges, and forged-steel boiler nozzles.

THE ALLIS-CHALMERS MANUFACTURING CO., Milwaukee, Wis.; booklet, 5 x 8½ in., 61 pages, illustrated; describes the works and products of the company.

THE COREY MFG. CO., Marshfield, Ore.; folder, 3½ x 6¼ in., eight pages, illustrated; describes the Corey banding tool for placing large wire bands around wood-stave or metal pipe.

THE CEMENT GUN CONSTRUCTION CO., of 900 S. Michigan Ave., Chicago; pamphlet, 6 x 9 in., 24 pages; illustrated; shows views of numerous structures built up by or covered protectively by the cement gun.

THE AMERICAN CEMENT MACHINE CO., INC., of Keokuk, Iowa; catalog, 8½ x 11 in., 9 pages, illustrated; describes "Boss" concrete mixers.